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The committee of the Boston City Council, which has had under consideration the proposal to construct a new city hall has submitted a majority and minority report. The majority report favors the construction of a city hall on plans submitted by the City Architect, at an estimated cost of $2,400,000, or 46 1-3 cts. per cu. ft. The minority report states that making due allowance for contingencies and changes of plan, the proposed building will probably cost at least $3,500,000, and the additional cost of the necessary land will bring the total to nearly $6,000,000. Considering that the proposed rapid transit scheme calls for an outlay by the city in street improvements of $13,000,000, with an additional outlay of some part of the $15,000,000, which the proposed railways and tunnels will cost, and that the changes which the new transit facilities will furnish may greatly alter the business districts of the city and make a different site from that now proposed the best for a new city hall, the minority advise that the matter be postponed.

In the committee's investigation it has visited the public buildings of various cities, and the report contains the following statistics of the City Hall in each:

City Hall:

City.	Material	Size; ft.	Floor area sq. ft.	Total.	Cost per cu. ft., cts.
Detroit	Fr'stone	....	212,170	$600,000	18
Chicago	.....	....	....	4,500,000	(a)
St. Louis	Granite	....	....	2,000,000	38
Cincin'ti	S'dstone	332x284	187,792	1,500,000	42
Richmond	Granite	180x140	....	1,500,000	
Baltimore	Marble	238x149	184,839	2,271,135	66
Philad'hia	.....	470x486	1,147,672	16,000,000	58
Buffalo	Granite	276x160	190,932	.....	51

Commenting on the Philadelphia City Hall, the committee say: "It is somewhat difficult to decide to what order or style of architecture this magnificent building may be credited." The Boston Aldermen are not the only persons who have met this difficulty.

The pollution of rivers is the subject of an elaborate report which has been submitted to the Joint Rivers Committee, of Manchester, Eng., by Sir Henry E. Roscoe, and which contains some points of special interest, especially regarding the various kinds of pollutions. It is said by "Industries," London, that with reference to calico printing works, the report recommends the separation of the wash liquor from the dye refuse, as it only contains a small amount of color, and does not require the drastic treatment which the remainder of the effluent needs. The waste dye liquor, it is recommended, should be dealt with by subsidence and filtration, but liberty should be given to each manufacturer to deal with it in the best way possible. Bleachworks refuse is not looked upon as obnoxious except when in excess, but the lime sludge left after making bleaching liquor should be rigidly excluded from the rivers. The pollution from wool scouring, fulling, and felting is described as serious, but an actual instance shows it can be easily treated, and much of the refuse oils recovered. Paper works refuse, it is proposed, should be treated by allowing the dirt, lime and fibrous matter to settle, and by evaporating the soda liquors in which the esparto straw, etc., has been boiled. The latter process is said to be profitable. All waste from tan-yards and fellmongers' works must be absolutely prevented from entering the stream. Chemical works matter, especially of a tarry character, should be kept out of the streams. The report was adopted, but it was agreed that no unnecessary difficulties should be thrown in the way of manufacturers. It has been resolved to proceed against the cities of Bury and Macclesfield to enforce the provision of sewage works.

(a) 29 cts. per cu. ft. for county division, 58 cts. for city division.

The announcement that the Spiral Weld Tube Co. has been placed in the hands of receivers will be received with general regret, since the process developed by the company was one of such ingenuity and real mechanical excellence that those who invested in the company deserved to reap a fair return. It is not the first enterprise of merit, however, which has not rewarded its owners at first. The reasons for the company's failure are: First, the great amount of capital which has been sunk in experimental work and in developing the plant and process to its present stage; secondly, the sending out of some imperfect pipe in the early history of the company, the defects of which have injured the reputation of the pipe in the West, where the principal market for it has been found; thirdly, the great reduction in the prices of cast iron pipe which, four years ago, was selling at $30 to $35 per ton, and can now be bought at $20 to $25 per ton, or even less. The company's assets are ample to meet its liabilities, and the only losers will be the stockholders. It is probable that a reorganization will be effected and that the company will resume business on a more solid financial basis. It is to be hoped that this may be the case, for it would be a pity to have an industry, on the perfection of which so much time and money have been spent, totally abandoned.

Irrigation in Burmah has been reported upon to the Government of India by Col. Home, Inspector-General of Irrigation. He is satisfied that irrigation works in the dry zone are not only urgently needed, but that the water will be eagerly taken and intelligently used. The minor works will yield large profits, and the outlay will be speedily recouped in direct revenue. The major works are all promising, and are likely to justify their construction from the loan funds. The works are required to stop emigration, and to admit a suitable settlement of the land revenue. It is hoped to convince the Financial Department that it will be sound policy to borrow specially for both railways and irrigation in Burmah.

Appropriations for the proposed Lake Erie & Ohio River ship canal were favored in a resolution adopted by the Pennsylvania Republican Convention.

The most serious railway accident of the week was a head collision May 15 on the Cleveland, Cincinnati, Chicago & St. Louis R. R., near Cleves, O. An eastbound freight train had orders to pass a westbound passenger train at North Bend, but the engineman apparently forgot his orders, as he generally had orders to pass at another station. The two trains were running at full speed when the collision occurred, and both engines and a number of cars were wrecked. There were five men killed and six injured.

An explosion in a coal mine occurred May 10 at Roslyn, Wash., by which 34 men were killed. The men were working with naked lamps, and it is supposed that a gas pocket was struck. The mine is one belonging to the Northern Pacific Coal Co., and is said to have been in good condition for ventilation and safety.

A bridge accident occurred May 1, on the Chicago & Eastern Illinois R. R., at Cayuga, Ind. The bridge was a single span structure across the Vermillion River, and was an iron Pratt truss, 178 ft. c. to c. of end pins, built in 1884 by the Smith Bridge Co. It was knocked down and so badly broken that a new bridge will have to be erected. For the above particulars we are indebted to Mr. C. H. Rockwell, General Superintendent, who also writes us as follows:

The cause of the accident, as near as can be ascertained, is as follows: The bridge was located 600 ft. north of Cayuga water tank. A freight train with loaded cars in the front and rear and empties between was going south. The engine with first part of train stopped at the water tank; just after they stopped the engine was knocked forward past the water tank, and immediately after that the bridge fell. The supposition is that the train had broken in two and ran together at the north end of the bridge, and that one of the empty cars (a flat car) was knocked out sidewise against the end post at the northwest corner of the bridge. There were no marks on the ties to show that there was a derailment before the bridge was reached. The bridge with 13 empties and one loaded car went into the river, and the north end of the bridge was turned over on the west side so that it was impossible to examine the west truss for confirmation of this theory. The bridge was very carefully examined in December, 1891, and a stress sheet made showing the stresses in various manners, and unless there was some defect in the material in the bridge which it was impossible to see, the bridge could not have failed from the weights that had gone over it. This, together with the manner in which the bridge and cars fell into the stream, make it probable that the above theory as to cause of the failure of the bridge is the correct one.

A trestle accident somewhat similar to that described last week occurred May 2 at Otis, Ind., on the Louisville, New Albany & Chicago Ry., being caused by a washout. A feight train went down and three men were killed. Mr. J. S. Collins, General Superintendent, states that it was a wooden pile trestle 92 ft. long, with six spans, all of which were damaged. The structure was 3½ years old. In regard to the accident Mr. Collins writes us as follows:

The accident was caused by the breaking away of a dam 150 ft. above the trestle. When the dam gave way, it took part of a saw mill with it which lodged against the trestle, causing an immense pressure of water against it, and forming an undercurrent which washed the channel of the river very deeply. The pond above the dam covered about 200 acres, and was from 10 to 15 ft. deep. There was no evidence of any prior derailment. The engine and eight cars went through the bridge, killing the engineer, fireman and forward brakeman. The physical loss will not be very heavy, as the cars were loaded with pig iron, lumber and coal. The cars that went through the bridge were totally wrecked, but the locomotive was not badly damaged.

Spongilla, which made a part of the Boston water supply so objectionable in 1881, has developed in the water supply of Hartford, Conn., and is giving much trouble. While not considered as dangerous to health, the spongilla gives the water a very disagreeable, fishy odor. The supply at Hartford is drawn entirely from storage reservoirs except in times of drought, when water is pumped from the Connecticut River.

Railways in China seem likely to be extended, as it is reported that an English railway supply firm, Bolling & Lowe, of London, has an order from the Chinese government for 6,200 tons of rails and 750 tons of splice bars, bolts, spikes, etc.

Locomotive driving wheels 7 ft. diameter will probably be tried on the New York Central R. R., and Mr. Buchanan, the Superintendent of Motive Power, has made provision for the equipment of four fast passenger engines with driving wheels of this size when the company directs, or faster schedules are called for than are now allowed for in the passenger service. In regard to the substitution of driving wheels 6 ft. 6 ins. diameter for those of 5 ft. 8 ins., formerly used on the fastest passenger engines on this road, recent tests made on the Empire State express have shown a better relative efficiency with the larger wheels than with the smaller wheels and employed in slower schedule.

A protest against the proposed bridge of the New York & New Jersey Bridge Co., terminating near 72d St. and thence running down by an elevated line to 35th St. (we believe) has been made by the West Side Association in a letter to Mayor Grant, the association sustaining the Mayor's opposition to the bill now pending before Congress. The special complaint is against the damage to property values which will be caused by the approaches, which are to be on or near 72d St., where real estate now commands high prices, and where many fine buildings have been erected. It is also claimed, with reason, that the bridge, if built, would be too far up town. The location of Mr. Lindenthal's proposed North River bridge, terminating near 6th Ave. and 28th St., is alleged to be much more satisfactory.

Petroleum fuel for locomotives has been successfully introduced in South America, on the Argentine Great Western Ry., native oil being used, but it is said that the supplies have given out, and the engines have once more to work with coal and wood. The petroleum deposits are situated in the province of Mendoza, and are the property of the Mendoza Petroleum Co. The crude oil, of a consistency resembling very coarse molasses, is brought down in a 4-in. pipe to the works of the company, a quarter of a mile from the railway station, and is stored in a large tank reservoir, with a capacity of 3,000 tons. It seems that the company has not carried its borings deep enough, and will have to make further sinkings to secure the constant supply which the deposits are expected to yield.

THE NEW HIGH SERVICE WATER TOWER AT YONKERS, N. Y.

The high service water tower now being built at Yonkers, N. Y., has unusual artistic merit, combined with good engineering design and detail, as the accompanying view of the structure, detailed drawings and descriptive matter attest.

Yonkers already has a high service water tank, the bottom of which is 418½ ft. above tide. The capacity of the old tank, however, is only 40,000 gallons, while that of the new structure will be about 280,000 gallons. The new water tower will be supplied from the old one, or at least from a 12-in. supply pipe about 9,000 ft. long, leading from the old high service district to the new tower.

Fig. 1 is a perspective view of the tower. Fig. 2

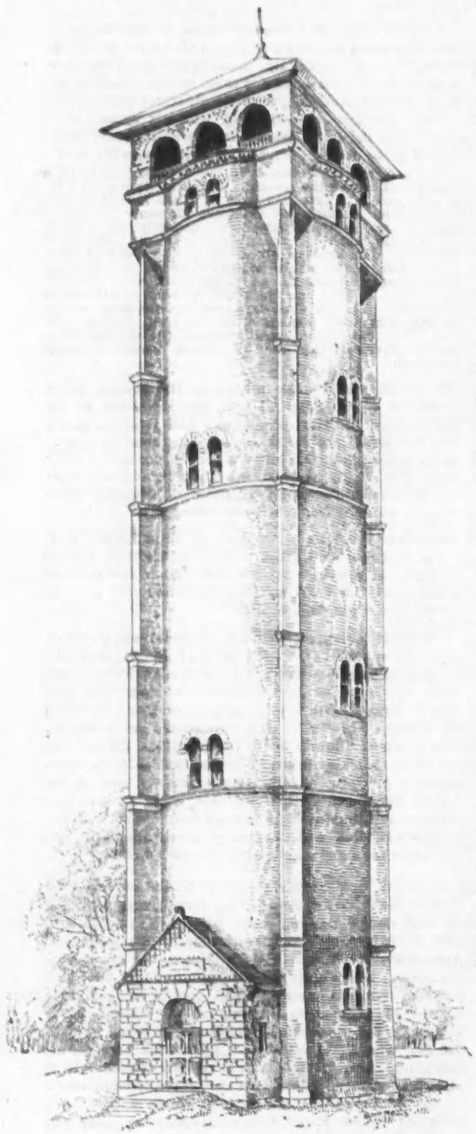


Fig. 1. High Service Water Tower at Yonkers, N. Y.

is a plan of the foundations, and Fig. 3 of the first story. Fig. 4 is a vertical section through the whole structure. The foundations are upon rock, and are separate for the masonry tower and stand-pipe, to prevent harm to either by unequal settlement.

The contractors for the metal work, or the stand-pipe, are Messrs. Morris, Tasker & Co., Philadelphia. The pipe will be 20 ft. in diameter and 122 ft. high. The material is Bessemer steel made by the Pottstown Iron Co. The thickness of the lower rings is 11-16th of an inch, based on a tensile strength of 60,000 lbs. per sq. in. of metal, allowing 65% for the strength of riveted joints, using a factor of safety of 3½ and adding a constant of 0.⅛ in. The plates diminish in thickness by 1-16 in. to the last four plates at the top, which are ¼ in. thick.

The contract for steel requires an elastic limit of at least 33,000 lbs. per sq. in.; an ultimate tensile strength of from 56,000 to 66,000 lbs. per sq. in.; an elongation in 8 ins. of at least 20%, and a reduction of area of at least 45%. The inspection of the works was made by Messrs. Hunt & Clapp, of the Pittsburg Testing Laboratory. According to their report the actual conditions developed were as follows: Elastic limit from 34,020 to 39,420; the tensile strength from 58,330 to 65,390; the elongation in 8 ins. from 22½ to 32%; reduction in area from 52.72 to 71.32%; 17 plates out of 141 were rejected in the inspection.

The connection with the stand-pipe is made through an arched brick culvert 6 ft. wide by 7 ft. high extending beneath the foundations.

The arrangement of pipes and valves in this culvert, the connection between the pipes and stand-pipe and details of the bottom of the stand-pipe are shown in Fig. 5. The stand-pipe can be filled or emptied by operating valves entirely within the building, but for safety two additional valves are provided outside of the building, either of which can be used to cut off the water.

The tower is located on the north side of Elm St., upon an elevation over 300 ft. above tide-water. In the construction of the main tower Warsaw blue stone is used in the foundation, vestibule and entrance porch, and brick for the main walls, the buttresses being faced with dark Croton front brick, with the belt courses, caps and cornice of terra cotta. Upon either side of the entrance are panels in which will be placed bronze tablets containing the names of the water commissioners, engineer and architect, while over the doorway there will be a stone tablet with the inscription: "Yonkers Water-Works" and the date of erection.

The diameter of the tower at the base is 32 ft. and at the top 30 ft., the walls being carried plumb on the inside and reduced in thickness at intervals from the outside. The belvidere story is square, with arched openings on every side, from which an extensive view of the surrounding country can be had, including the Hudson River from the Highlands to Staten Island, the East River and Long Island Sound. Easy iron stairs 3 ft. wide will lead from the ground floor to the top, where there will be a floor of steel beams and concrete, surrounded with a terra cotta and iron railing. The outlook is upward of 450 ft. above the sea.

The contracts for the tower were awarded on Sept. 7, 1891; the ceremony of laying the corner stone took place on Nov. 12, 1891, and it is expected that the entire structure and water service will be completed and in operation early in the summer.

Messrs. Edwin A. Quick & Son are the architects for the tower, and Mr. Wm. H. Baldwin the engineer, all of Yonkers. Mr. Baldwin is also engineer of the Yonkers water-works. We are indebted to each of the above for drawings and information given.

An electrolytic refining plant is to be put in at the works of the Boston & Montana Mining & Smelting Co., in Montana, in connection with the new smelter. The contract has been let to the Thomson-Houston Co.

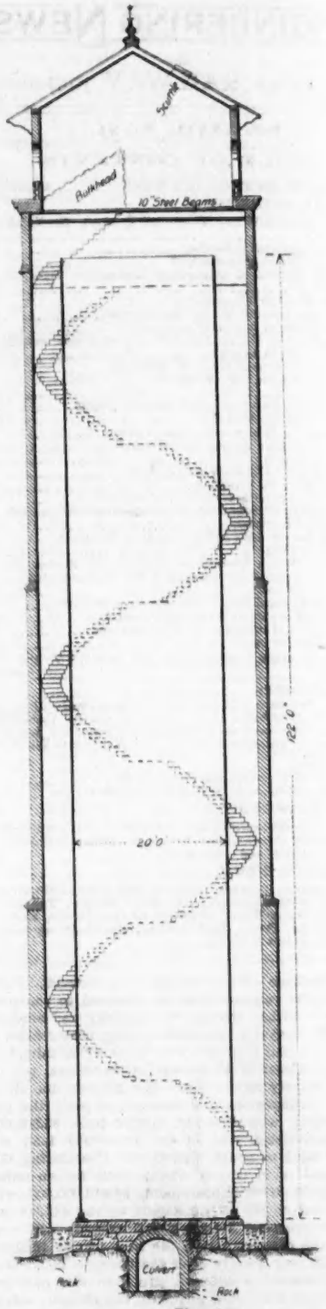


Fig. 4.

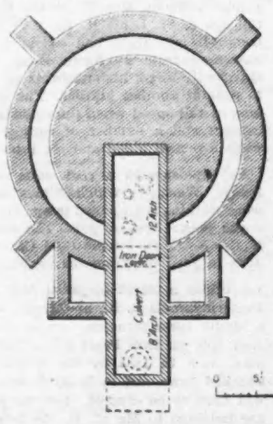


Fig. 2.

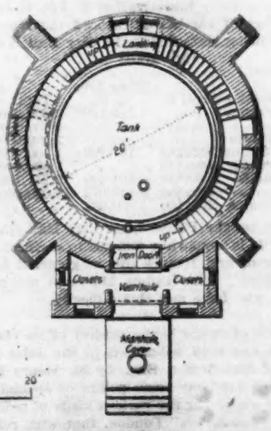


Fig. 3.

SECTIONS OF YONKERS WATER TOWER.

A NEW SELF-LUBRICATING BEARING.

The valuable qualities of graphite as a lubricating material are well known, and have long been made use of in connection with the lubrication of large bearings requiring heavy pressure. For high speed bearings under very light pressures graphite has also been used in connection with metal shells into which the graphite is inserted, either in spiral grooves or in holes bored into the shell. A bearing made in the latter way, known in the trade as the metalined bearing, was illustrated and described in our issue of Feb. 8, 1890. As there stated, the limits to the use of these bearings are pretty clearly defined. They are not intended to compete with bearings on which oil could conveniently be used; they are not run except under moderate unit pressures; they will not work well in temperatures above 275° or 300°. Further, they require the shaft and bearing to be set up in first-class shape, the shaft to be well lined and the bearing carefully fitted; even with all these precautions, the manufacturers have not recommended their use for shafts less than ¾-in. or more than 3½ ins. in diameter.

These numerous limitations to the application of metalined bearings, together with the fact that they are quite expensive, have caused them to be little used, so little, in fact, that the merits they possess have not been generally appreciated by machine designers. The new bearing to which we wish to call our readers' attention, however, has been proved by actual trial to work successfully in almost every place where ordinary bearings are now used, with the exception of bearings under pressures higher than about 50 lbs. per sq. in. Even for these it is possible that it may yet be adopted, as we shall show further on.

We desire to lay especial stress on the general applicability of this new bearing, because the engineer, on hearing of the new invention, is apt to class it with the graphite bearings which have been heretofore in use and which have been usually applied only to such light machinery as fan blowers for restaurants, light textile machinery, etc. We ourselves supposed at first that the new bearing was merely intended to compete with the old forms of graphite bearing; and we did not appreciate the possibility that the new material may work a real revolution in many departments of machine construction, and may to a large extent do away with the use of oil and of expensive bearing metals, until we had examined the record of service which has been performed by these bearings.

The material of the new bearing is practically an intimate mixture of graphite and wood pulp. The graphite is carefully selected to insure the rejection of all grit, and is crushed to an impalpable powder. It is then thoroughly mixed with the moist wood pulp in proportions varied somewhat according to the use to which the material is to be put. The mixture is then pressed into molds having perforated sides from which the water can escape. It is also stated that the pressure is arranged to cause the ends of the fibers to be presented to the bearing surface. After air-drying the solidified mass, it is soaked in a drying oil and thoroughly baked; this oil, we believe, serves as a cementing material and tends to give the dried mass something of the toughness and elasticity of the linoleum which is so much used for floor coverings. As proof of this it is stated that the material will resist without injury long-continued and quite severe hammering action which would deform the surface of ordinary bearing metals.

The material is molded either into the shape of the bearings or into "stock" shapes, from which the bearings can be cut with ordinary metal working tools.

The inventor of this new material is Mr. Philip H. Holmes, of Gardiner, Me., and his first bearings were made and put in service in his own shops about three years ago. Five of these bearings were at that time placed on the line shafting in the charging house of the foundry immediately under the coke loft, a trying place for bearings on account of the dust and heat. These bearings are still running satisfactorily and have never been oiled. To test the durability of the material as a step bearing when exposed to water and under heavy pressure, a vertical shaft exerting a pressure of 300 lbs. was run at 470 revs. per min. The lower end of the shaft was an obtuse angled cone 2 ins. in diameter. After three months' running the tool marks were not all worn out, nor was any detrimental effect observable from submersion or abrasion.

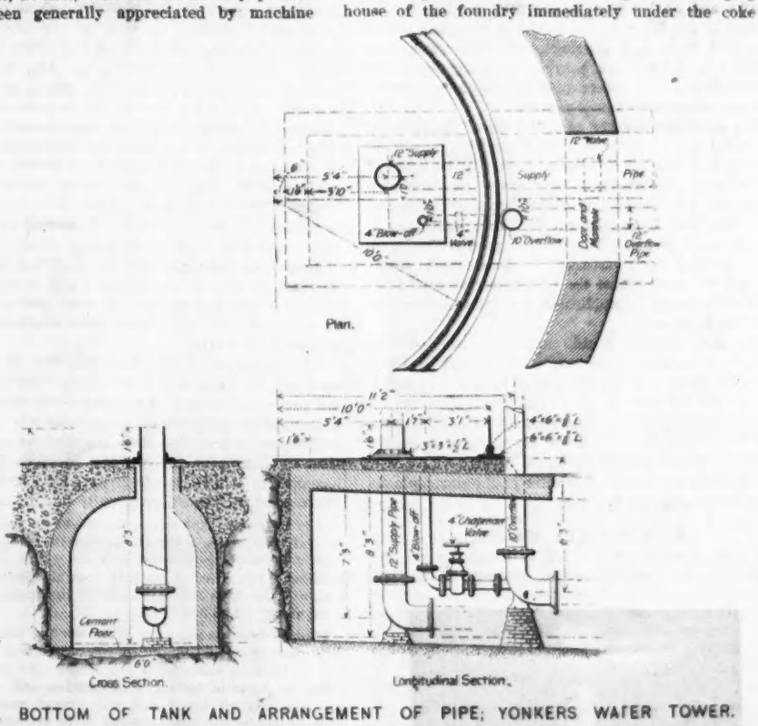


FIG. 5. BOTTOM OF TANK AND ARRANGEMENT OF PIPE; YONKERS WATER TOWER.

The Philadelphia Traction Co. has used the fiber graphite bearings since April, 1891, in the tension pit at the Samson St. power house of their cable railway, and since September last has had them in use on the cable carrying sheaves in the street conduits. The chief engineer, Mr. J. S. Ely, stated on Jan. 13 that the tension pit bearings ran cold and were in first-class condition. The conduit pulley bearings, although submerged in water part of the time, were as good as when first put in.

Under high velocities the bearings have been used for the spindles of textile machinery making 9,000 to 10,000 revs. per min. for nine months, and showed no wear on either bearings or spindles. The greatest heat developed at any time was but little above that of the hand. In a Lewiston, Me., mill a McMullen spindle in a fiber-graphite bushing was run for 15 weeks at 8,200 revs. per minute, and every morning a new driving cord was stretched upon it as tightly as a strong man could draw it. At the end of that time a follower was pushed into the bushing which fitted it when new, and no wear could be discerned. The overseer of the spinning department also stated that the spindle ran with less heat than similar spindles running in oiled bearings, indicating that the friction of the fiber-graphite bearing was less.

This fact has also been proved by a series of tests made by three persons at different times and places to determine the relative power required to drive the Rabbeth spindle fitted with fiber-graphite bearings and with ordinary metal bearings which were supplied with the best grade of spindle oil. The total number of tests was 128. The power was measured by the Emerson power scale upon the drum shaft which directly drives the spindles. The tests showed an average saving of power of 25% by the use of the fiber-graphite bearings. The lowest percentage of saving in the tests was 17%.

So much for the record made by this material in actual service. Experiments with it have further shown that it is not affected by water, oils, acids, alkalies, or by a moderate degree of heat. It does not noticeably expand and contract with changes of temperature. It is also claimed that shafts running in these bearings show hardly a sign of wear, and that the accurate and smooth finish of the shaft which is essential to the satisfactory running of high speed machinery with metal bearings is not necessary with fiber-graphite bearings. When a new shaft is set running in a fiber graphite bearing it at once wears away enough material from the bearing to fill all the cavities and irregularities of the shaft, and takes on a film-like coating of the graphite. Thereafter the motion takes place between graphite surfaces, and the metal of the shaft itself is protected from wear. In proof of this two bearings were applied to a shaft which had given serious trouble from heating, and the journals had become rough in consequence. Seven months afterward an examination showed the journals still rough but very highly polished, while the bearings were in as good condition as when put in.

Another remarkable quality of the fiber-graphite bearing is that the friction at starting is about the same as when in motion. This is vouched for by the Franklin Institute Committee which reported on this invention. Why this should be so, provided the other claims for the material are well founded, is not difficult to see. When a well-oiled bearing is in motion the rubbing surfaces are separated by a film of oil; when motion ceases the oil between part of these surfaces is squeezed out and the metal of the shaft comes in contact with the metal of the bearing. When the shaft begins to turn again some time is required to distribute the oil thoroughly between the sliding surfaces. With the "integral lubrication," which the fiber-graphite bearing effects, the surfaces in contact are always lubricated, whether in motion or at rest.

Not the least of the advantages claimed for the fiber-graphite bearings is that their first cost will be no more than that of the ordinary metal bearings. Mr. John H. Cooper, M. Am. Soc. M. E., says that the experience thus far had in their manufacture has thoroughly proved this. The materials used are all cheap and obtainable in any desired quantity, and the process of manufacture is a simple and expeditious one.

When one turns to the applications which may be made of this invention, provided the performances which are reported to us are fair representations of its future capabilities, the number and variety of uses to which it may be put is marvelous. Taking up first only those uses for which it has been actually tested, the bearings of spindles in textile machinery offers one enormous field for it. There are about 175,000,000 spindles in England and America. The speeds of 8,000 to 12,000 revolutions at which they are run makes lubrication a most important matter; in fact, the speeds at which they can be run and the amount of work which can be accomplished depend largely upon the perfection of the lubrication. If the fiber-graphite bearings will reduce the friction 25%, it is possible that a considerable increase in the speeds of spindles may be made.

Another application of the material is for cun-

mutator brushes on electric dynamos. Here good lubrication is combined with ample conductivity, and the material has thoroughly proved its good qualities by many months' service on both arc and incandescent dynamos.

A still more novel application is for the packing rings of projectiles for rifled guns. Of this Mr. John H. Cooper says:

The rapid destruction of the interior of a rifled cannon gun is due largely to the use of copper rings and grease. The effect of high heat upon iron and steel, with grease in contact, is to corrode them, and the result of the contact of copper with iron or steel, under the excitement of heat and the components of ignited gunpowder, must be detrimental by galvanic action to the smooth and even surface of the grooves in the bore of the gun; as a consequence the copper ring, as a piston, does not fit its cylinder and must therefore permit escape of the gases, producing a violent sandblast against the walls of the bore, which, in addition to the other injurious effects, shortens the life of the gun.

The excellent lubricating and the high refractory qualities of graphite, combined with the tenacity and elasticity of the bonding material in the make-up of these rings by the Holmes method, together with the readiness of graphite to adhere to and to fill the pores of any surface against which it is rubbed, renders the fiber-graphite rings for this purpose, a material superior to any metal.

As each projectile is driven through the gun the ring is forced to take the form of the grooves, to which it freely conforms, filling them completely and at the same time smearing the bore and grooves of the gun with graphite, which protects it from the effects of rust, fire and erosion.

This material has been put to the test (under United States Government supervision) in a rifled gun of 3.67 ins. diameter of bore, using a 16-lb. conical cast iron projectile. The evidence is conclusive, from careful observation during several tests, that these projectiles were in continued revolution throughout their whole course, the rings filled the grooves, and the interior of the gun was glazed with graphite from end to end.

For loose pulleys the advantages of the fiber-graphite bearing are obvious. Prof. Coleman Sellers says:

I have examined with very great attention and care the action of loose pulleys upon shafts, the loose pulley being bushed with this Holmes material. I find that they run freely, do not show wear, give no indication of excessive heat under reasonable conditions of speed, and do away with the annoyance of oil, which, by the revolution of the pulley is carried out to the revolving ends and there thrown off and lost.

We quote further from Prof. Sellers' report to a committee of the Franklin Institute, detailing experiments upon the invention:

Comparing this substance with the so-called anti-friction metals used to line or cover the bearing surfaces, I find from some experiments of my own that when emery of the best quality is introduced between a graphite block and a metal plate, the cutting action of the emery is of very short duration as compared to the use of the same emery on the same metal, the rubbing block loaded with emery being made of the best anti-friction metal. These so-called anti-friction metals hold the emery, and the cutting power continues as long as the particles of stone imbedded will last; but when applied to the block of fiber-graphite they seem immediately to become buried in the graphite, and the bearing substance itself furnishes a protection against cutting.

The experiments I have tried in this direction have all been favorable to the Holmes mixture; but one of the most important qualities connected with it is its ability to resist long-continued hammering action. I find that a solid block of the Holmes graphite mixture will bear an amount of hammering that would quite deform the surface of the metals commonly used for bearings.

The ideal bearing surface must be so different in its nature from the metal that slides upon it as to be unable to weld or unite therewith, and at the same time it must, in many cases, be able to bear long-continued vibratory or hammering action, that is incident to unbalanced machinery and much of the services on railroads. . . .

I find the Holmes preparation to be a substance that under light pressures certainly has a lower frictional equivalent than metal surfaces under the best conditions, lubricated by oils other than of the most costly character. There seems to be, under those conditions, no appreciable wear either of the bearing or the spindle, or other sliding surface working upon this material, even when the velocity is very great; and so far as I have been able to determine, the heat generated by the friction is no greater than we find with many lubricated bearings that are under no greater pressure but that have as great velocity.

I am unprepared at present to state how far the Holmes composition of graphite can be used under the severe pressures that occur in some cases in machinery, but even in that direction there seems to be a chance for excellent results to be obtained where the material can be prevented from spreading by sufficiently firm surrounding walls.

As further evidence of the character of the invention, the committee of the Franklin Institute which made a report upon it and awarded to its inventor the Elliott Cresson gold medal included Messrs. J. Sellers Bancroft, manager of Wm. Sellers & Co.; Prof. H. W. Spangler, U. S. N., professor of mechanical engineering, University of Pennsylvania, and S. M. Vauclain, of the Baldwin Locomotive Works. Among the officers of the Holmes Fiber-Graphite Manufacturing Co. are Wm. D. Ewart, Jas. M. Dodge, S. Howard-Smith and Edward H. Burr, who are at the head of the Link-Belt Machinery Co.

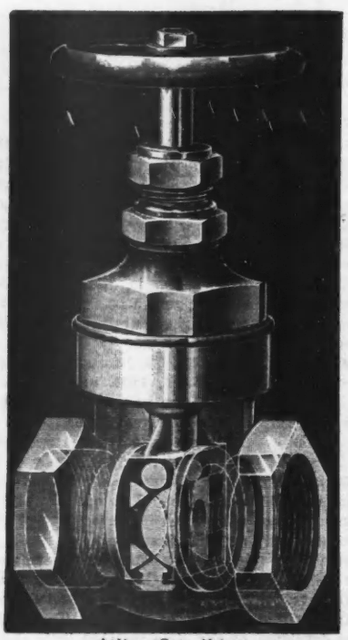
Doubtless, it is yet too soon to state exact limits to the application of this invention, but wherever it can be used the gain will be beyond realization. The added first cost of machinery due to the necessary provisions for oiling, the cost of bearing metals, the cost of the oil used in lubrication, the attendance necessary to maintain the lubrication, the wear on shafts and on bearings in ordinary service, the increase in the fire risk due to the storage and use of oils and from hot bearings,—all these would be avoided by the use of a bearing requiring no lubrication and having the other qualities which the Holmes bearing seems thus far to possess.

The results of further careful tests of the material in actual service in many other situations than those in which it has already been tried will be awaited with interest. Perhaps it may prove, as often happens with new devices, that the extent of its usefulness has been overestimated by those interested in it; but since so much is stated on good authority to have already been successfully done, there seems ground for hoping that the new material may have as wide a range of applicability as the metals now used for bearings.

For facts related in this article we are indebted to the company's prospectus, to the report of Prof. Coleman Sellers to the Franklin Institute Committee, above referred to, and to a paper read at the current meeting of the American Society of Mechanical Engineers by Mr. John H. Cooper, formerly with the Southwark Foundry & Machine Co., and now associated with the inventor in the development of the fiber-graphite bearing.

A NEW GATE VALVE.

A new form of gate valve is being put on the market by the Ross Valve Co., of Troy, N. Y., and



A New Gate Valve.

is styled the "Mobile Wedge" valve by the makers. It has only recently been patented, but is said to be favorably considered by persons who have given it a trial. The new feature is the rolling action of the movable wedge by means of which a uniform pressure is exerted over the entire back of the gates, and this is accomplished without any sliding of the valves on their faces. There are two pair of X-shaped bearing blocks, with a rolling wedge between the pairs and a seating plunger which bears in the center of the valve case, when the valve is in a closed position, as shown in the accompanying cut. The pressure to seat the valves is applied on the seats, and bears with equal pressure at four points on each disk or gate. There is a positive movement which seats the valves without moving them on their faces. The gates or disks hang on trunnions and are free to revolve, thereby seating in a different place each time the gate is operated. This prolongs the life of the valve, and is said to make it easier to operate, especially in the large sizes.

A STANDARD METHOD OF CONDUCTING LOCOMOTIVE TESTS.

The committee of the American Society of Mechanical Engineers on this subject presented a preliminary report at the San Francisco convention, recommending that, in view of the fact that the Master Mechanics Association has appointed a committee on the same subject, the Am. Soc. M. E. should invite joint action and report by the two committees, in order to avoid the presentation of two different methods of testing and reporting results. The committee notes that the society has already formulated a standard method of testing stationary boilers, and a standard method of testing pumping engines, which have been widely used and generally accepted. A uniform method of testing locomotives, and a standard form for recording results have been regarded as equally important and desirable. The increasing use of compound locomotives in the United States has resulted in more locomotive tests in the past year than have been conducted in the previous five years.

The committee thinks, however, that the superior economy of compound over simple locomotives has not yet been shown on American locomotives in such a manner as to convince many who rely on actual and accurate tests for their conclusions, and hence that the necessity for uniform methods in testing locomotives is now much greater than ever before. We reprint the report, practically in full, as follows:

It is desirable that locomotive tests be made with a special train when possible, so that the same cars are used for the different trips, and the weight of train is uniform. The speed of the train can also be under control, and the tests not hampered by the rules governing a regularly scheduled train.

When a dynamometer car is not used, we recommend as a final basis of comparison of locomotives the number of thermal units used per I. HP. per hour. The object in view in testing a locomotive will determine the methods employed and the extent and kind of data necessary to obtain. Some tests are made to ascertain the economy of a particular kind of boiler or firebox; others, the value of employing compound cylinders; others, to ascertain the relative merits of certain coals for locomotive use. As a practical and commercial unit the amount of coal used per ton-mile may be used.

For a coal test we give a separate method and a form (D), for tabulating results. For a unit of comparison of boiler tests we recommend the number of thermal units (lbs. Fahr.) taken up every hour by the water and steam in the boiler. For a measurement of the resistance overcome in hauling a train, a dynamometer car is essential, and we give a method of operating a dynamometer car and of recording results. For a uniform method of recording results of indicator tests, we recommend the form (A). For tabulating general results, form (B) is presented.

The waste from the injector should be ascertained by catching it in a vessel conveniently attached, or by starting the injector several times in the engine house and catching the overflow in a tub. The total weight of the water caught divided by the number of applications of the injector gives the average waste. The observer in the cab should keep a record of the number of times the injector is applied during the trips, and thus obtain data for estimating the total waste.

Fuel Measurements.—The measurement of fuel in locomotive tests is not difficult so far as a determination of the total amount shoveled into the fire is concerned. A weighed amount may be shoveled into the tank, and

the amount remaining, after a given run, be weighed to determine the amount used, provided no water is used to wet down the coal. But it is next to impossible to determine the amount of coal used at any particular portion of a run when the coal is put in the tender in bulk. If coal is put in sacks containing 125 lbs. each, with a small amount of weighed coal on the foot plate, it is found quite possible, even with heavy firing, for the fireman to cut open the bags, and dump the coal on the foot plate as needed. In this way the rate of consumption on difficult portions of the run could readily be estimated. The use of water meters and of coal in sacks obviates any need of weighing the tender, and thus removes one of the largest inaccuracies incident to the ordinary locomotive tests. To determine the amount of coal used during the trip, it is only necessary to count the number of bags which have been emptied.

However, the determination of the amount of fuel used during a run is not all that is necessary for a test. The measurement of the fire line before and after a test is very essential and extremely difficult. If the run is a long one, then the errors in the determination of the fire line may not be great; but for short runs there seems to be no way of measuring the difference between the heat value of coal in the fire before the test and after with sufficient accuracy to give reliable data. In tests made on a heavy grade one trip closely succeeding another, it is, of course, impracticable to drop the fire and measure the amount of fuel in the ashes remaining. Such measurements are unsatisfactory and inaccurate in any case, because it is not practicable to draw the fire without wetting it, as the ashes rise into the machinery, and they are too hot to handle. When one run succeeds another within a short space of time, some other method is necessary for measuring fuel used than by dumping the coal.

The test is commenced with a good fire in the furnace, and the height of coal estimated by two or more assistants engaged in the trial. At the end of the run the fire should be in the same condition as near as possible. No raw coal should be in the box and the steam pressure and pyrometer temperature should be falling.

Application of the Indicator.—If the power of the engine is to be determined, the action of the valve gear examined, or the coal and water used per unit of power in a unit of time, the indicator must be used. This instrument should be attached to a three-way cock just at the outer edge of the steam chest, in order that the connecting pipes (which should be ¾ in. in diameter) can go directly in a diagonal direction

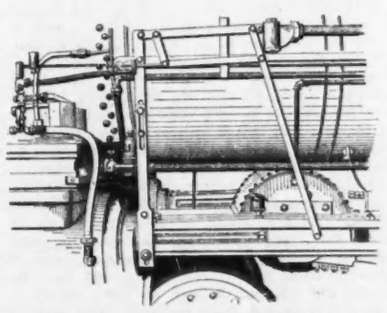


Fig. 1. Method of Attaching Indicator to Locomotive.

to holes tapped into the sides of the cylinder rather than into the heads (Fig. 1). By this arrangement the pipes are shorter than when they pass over the steam chest into the heads, and have but short horizontal portions, thus facilitating the rapid draining of the pipes. Moreover, if a cylinder head is knocked out, the pipes are not dragged off and the operator and indicator escape injury. The indicator should not be placed on horizontal pipes on a level with the axis of the cylinder heads.

The indicator pipes and three-way cock should be covered with a non-conductor, wrapped with canvas and painted. The indicator itself should be wrapped as high as the vent holes. (See Fig. 1.) The indicator gear may be a rigid, true pantograph motion, either fixed or adjustable in height, or it may be a simple pendulum connected by a link to the cross-head with a wooden quadrant 2 ins. thick, and having a radius such as will make the indicator card 3 ins. long. The cord of the indicator should be 8 or 10 ins. long, and connected with a rod reaching forward from the pantograph. In order to determine the steam chest pressure, the indicator should be so piped that a steam chest diagram can be drawn by it. A steam gage on the chest is inaccurate and difficult to use.

Indicator diagrams should be taken at equal distances instead of at equal time intervals, in order to properly average the power. They should, therefore, be taken at mile posts. The signal for taking diagrams should be given by the observer in the cab, who can pull a cord and ring a bell at the front of the engine, or blow the whistle.

For the safety of the operator at the indicator, it is recommended that the seat be on a piece of boiler plate above the cylinder, and so arranged that a piston or cylinder head can pass out without injuring him. The person who takes the indicator diagrams should be thoroughly sheltered by a temporary box containing a seat placed on the front end of the engine. Besides the usual indicator, there should be located near the observer a revolution counter, which should be so arranged that after starting out the instrument will continue to record the revolutions for a period of exactly one minute, starting every time from zero, and when the minute has elapsed the counter will stop; such an instrument is already in existence for taking the continuous revolutions of dynamos and high-speed engines, and little or no difficulty would be experienced in obtaining an instrument which would take the revolutions from some reciprocating part of the machinery.

It would also be very desirable to have an electric connection between the indicator instrument and the recording apparatus in the dynamometer car so that at the instant an indicator diagram is being taken the fact is registered on the diagram paper in the dynamometer diagram. The cards should be numbered consecutively and the record likewise.

Besides the person taking the indicator diagrams, another person should be located in the cab of the engine whose duty it should be to observe the point of cut off given by the position of the reverse lever, the position of the throttle lever, and the boiler pressure, all of which conditions should be recorded in a log book for this purpose. Besides recording on the dynamometer diagram the fact that an indicator card has to be taken, a bell should be rung at the same time, so as to call the attention of the observers in the dynamometer car to this fact.

FORM A.

.....Bound. .....189....

Results of Indicator Tests of Locomotive No.....

.....R. R. Co.

Cylinder Performance: (Numbers given below show columns in table in proposed form.)

1, 2, 3. Diameters and strokes of pistons.
4. Number and time of taking cards.
5. Number and time of passing mile posts.
6, 7. Revs. and piston speed per minute.
8, 9, 10, 11. Cut-off in inches and per cent. h. p. and l. p. cylinders.
12 to 25, inclusive, pressures from cards in each cylinder and steam chest, at various points of stroke, also mean effective pressures.
26, 27, 28, 29. I. HP. Left (or h. p.) cylinder. Right (or l. p.) cylinder, total, and difference between cylinders.
30, 31, 32. Fuel, water and steam accounted for by indicator per I. HP. per hour.
33. Percentage of 32 to 31.

Locomotive Boiler Tests—General Directions.—1. The drawing of the boiler to accompany the report of tests should be particular in specifying the construction in detail, with reference to coal burning and generating steam, such as: heating surface, grate area, and the distribution of openings through the grate, volume of firebox, size and thickness of flues, size of smokebox, and the arrangement for draft, together with the thickness of walls between the heating gases and the water in the boiler; the weight of the boiler itself should be given, and the number of cubic feet of water space and of steam space in the boiler, the division between the two to be taken at the middle of the range of the gages.

2. Boilers for tests should be thoroughly cleaned on both sides of the heating surface, by a removal of the flues, before any test is commenced, and these surfaces should be kept clean by frequent washing during the test. The following exception is made: When it is desired to make a comparison of boilers for the purpose of determining a difference between them as to incrustation, they should first be tested as above, when clean, and then tested again without further cleaning than the ordinary washing out of the boilers after the lapse of some months' service, which has resulted in the same evaporation per square foot of heating surface from both boilers, using the same water during that period.

3. In case the measure of the capacity of the locomotive boiler for generating steam be desirable, without reference to the engines forming the locomotive, this capacity should be measured by the number of British thermal units, taken up every hour by the water and steam in the boiler, which may be readily determined from the observed data of temperature of water fed to the boiler, pounds of water evaporated per hour, and steam pressure under which this evaporation occurs, by using any good set of steam tables, such as Peabody's and those contained in Porter's book on Richard's Steam Engine Indicator. In such cases it will be necessary to specify all the pertinent conditions under which such measure of the capacity of the boiler is made, so that in comparing with the capacity of another boiler all such conditions may be made as nearly alike as possible. It is, however, believed that a measure of the capacity of a locomotive boiler, without any reference to capacity or efficiency and method of working of the engines which such boiler feeds on the locomotive, will not be of particular value in comparison of boilers, unless the conditions under which the engines are worked with different boilers are identical, or nearly so.

4. On account of the important influence which the temperature and especially the moisture of the atmosphere have upon the results obtained in a boiler test, it is necessary to compare two or more boilers at the same place and at the same time to get results which may be strictly comparable. The temperature of the air should then be noted for record.

5. To properly determine the amount of water fed to a locomotive boiler in service on a locomotive during any test, it is necessary to use a good water meter, which should have its maximum error determined by previous tests, and given with the report.

6. The coal used should be dry when weighed, and placed in sacks, each one containing 100 or 125 lbs., care being taken to insure that all scales used are accurate. When an unusually large amount of coal is needed a weighed quantity of coal may be placed in the front of the tender and used first, and the test finished with coal from the sacks. An analysis of the coal used should accompany the report, which should show the volatile matter, the fixed carbons, etc., the moisture, and the ash contained in the coal. The ashes should be dried if they contain any moisture, and carefully weighed and recorded after each test run.

7. The temperature of the smokebox gases should be measured by a good pyrometer, located near enough to the flues in the smokebox to get the average temperature of the gases after they have passed the heating surface, and before they are mixed with the exhaust steam. Such pyrometers as that offered by

Fig. 2. Pyrometer for Testing Temperature in Smokebox.

Schaefer & Budenburg, or Weiskopf, are suitable. (Fig. 2.) These instruments cost about $35. They should register up to 1,200° F.

8. The degree of exhaustion in the smokebox should be measured and recorded by means of a simple manometer gage.

9. The quality of the steam furnished by the boiler to the engines should be determined by the most approved means, not yet determined upon by this committee.

10. Samples of gases passing from the flues to the smokebox should be analyzed and results reported. The means of taking such gases so as to insure perfect samples is to be further considered by this committee, and definite means prescribed.

Coal Tests.—The locomotive selected should be in good condition, and either a new engine or one that has lately undergone repairs. The boiler should be washed before commencing the trial, the steam gage tested, the flues cleaned, and the exhaust nozzles cleaned and measured, which operations should be performed also whenever the kind of coal is changed.

Instructions must be given to roundhouse foremen that no repairs or alterations of any sort be made to the engine without the approbation of the conductor of the trial. The engineman and fireman who operate the engine on the first trip should continue to operate the engine throughout the duration of the trial, and the same methods of firing and running should be strictly preserved.

The run selected must be one on which the same distance is covered on each trip. The trains must be through trains and unbroken from end to end of the run, and the same number of cars and same lading should be provided each trip. The same speed should, if possible, be preserved on all trips.

The conductor of the trial must be a person familiar with correct methods of firing and running locomotives, and must insist that the fireman adhere to well recognized good methods of firing, and that the same methods be preserved throughout the duration of the trial, so that all coals shall receive the same treatment.

He must also see that the coal supplied at coaling points is of the proper kind, and must weigh the coal personally, and keep an accurate record of the items necessary for filling forms D and B, together with notes of repairs to engine, and any other items that would be of importance.

For each kind of coal tested the following particulars should be noted:

Name of mine and operator, location of mine, physical quality of coal (appearance), steaming quality of coal, kind of fire made, clinkers and ashes, cinders in

smokebox, cleaning ash pan and smokebox, labor involved in firing.

The coals may finally be compared on the basis of evaporative performance and on the amount consumed per 100 ton-miles.

FORM D.

Locomotive Performance.—Coal Trial.

Trains Nos..... .....R. R. .....R. R. Locomotive class.....
Boiler Pressure..... lbs.
No.....
Distance.....Miles. Between A. & B.....
Fuel.....Coal.
Date.....
Number of round trips.
Date.
Weather.
Temperature of atmosphere, average.
Temperature of feed-water, average.
Steam pressure, average.
Time on road.
Running time.
Average running speed in miles per hour.
Number of cars in train.
Lbs. coal consumed per trip.
Lbs. water evaporated per trip.
Lbs. water evaporated per lb. coal.
Coal per car per mile.
Total weight of train in tons.
Tons hauled one mile.
Coal consumed per 100 tons per mile.
Remarks.

Water Measurements.—It has been found during the last year or two that meters are reliable and accurate within less than 1% for measuring the water used by a locomotive. The meters should be specially made for the purpose and if possible, free from any material

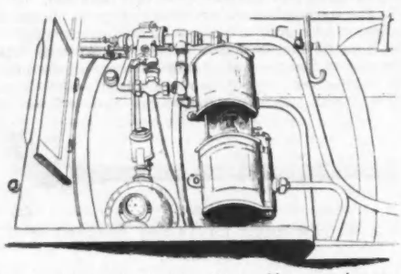


Fig. 3. Mode of Attaching Water Meter to Locomotive.

that is injured by contact with hot water. They should be placed so as to be read from the cab. (See Fig. 3.)

In mounting these meters, all pipes should be thoroughly cleaned before they are put into position, and a sufficiently large strainer should be placed between the meter and the tank. A most essential feature is to have a good flap check valve between the injector and the meter; otherwise the hot water may flow backward and ruin the rubber recording disks in the meter. As a check upon the meter, however, other means of measuring the water should be employed. The most convenient method is to use a float attached to a wooden rod which slides upon a graduated rod, the lower end of which rests upon the bottom of the tank. This rod is graduated to show 1,000 lbs., and subdivided to 250 lbs.

In general the float is placed in the manhole of the tank, but as this is not in the center of gravity of the water space, its readings are not quite correct if the two ends of the tank change their relative heights. This can be overcome by having a special small opening made at the center of gravity of the tank, or as near it as possible, and using a small float.

Another, but less convenient way, is to place a glass tube on each side of the tank opposite the center of gravity of the water space and to graduate scales behind them by the same method as above described. The objections to this method are the inconvenience in reading the scales (especially at way stations where there is but little time), their liability to freezing in cold weather, and the possibility of injuring them at any time. The float is always convenient and serviceable.

When locomotive boilers are being fired hard the water rises above the normal level, and a measurement of water just after the injectors have been throwing comparatively cold water into the boiler is not an accurate one; the water shrinks and swells according as the firing is hard or as the locomotive is being worked. Hence measurements taken under these variable conditions are necessarily approximations. There is also a continuous movement of the water in the water glass, and a mean of the oscillations is not quite satisfactory. Although the amount of water fed into the boiler can be determined exactly by the use of meters, yet the inaccuracies of the location of the water-line render water measurements on short runs almost impracticable. The six-hour test for a stationary engine is considered satisfactory when successive tests will give the same results; but in locomotive work, unless the engine be kept quiet, as it would be when tested in a shed, a short test is of little or no value. It may be accepted that a determination of the water-line by the sound of the gage cocks is too uncertain to be admissible in locomotive tests unless the run is a long one. In such cases the total amount of water used is so large that any errors in estimating the water level at the beginning or the end of the trip practically disappear.

A locomotive which is undergoing a test should have a water glass on the boiler. Behind this should be a piece of wood graduated; and surrounding the glass and fastened to the wood should be a copper wire at the height at which the water should be left at the end of every trip. The tank measurement should not be taken at the end of the trip until the water in the boiler is at the standard height. The temperature of the water should be taken as it enters the tank at every station where water is taken, and tank reading should be taken before and after each filling.

To test the leakage of the boiler, keep up as nearly as possible, without blowing off, the pressure to be carried, and note the fall of water in the water glass in a given time, say four hours. Of course, the injector must not be applied during this interval. The water meter can then be used to determine the amount lost by leakage by reading the dial, applying the injector until the water reaches the original level, and then taking a second reading. The difference will be the amount of water lost. All boilers lose more or less from this cause, and if the test is to be a comparison between two different styles, the necessity for this information is obvious.

Before beginning a test, the pistons, slide and throttle valves of the engine should be made tight. The point of cut-off for each notch of the quadrant should be ascertained, and the cut-off should be painted in white on the quadrant, or on boiler jacket, with pointer or lever. All leaks about the engine should be stopped. A graduated scale and index should be attached to the throttle rod to indicate its opening.

A special steam gage with a long siphon should be used for the boiler pressure and attached to the front of the cab at the left side so that it will not become incorrect from overheating. Readings of the gage, reverse quadrant, throttle scale and boiler height scale should be taken frequently, the first as often as once in 2½, 5 or 10 minutes, depending on length and character of run, and all with each indicator diagram, if the latter are being taken.

Just before beginning a trip the water in the boiler should be at the standard height and the tank reading taken in order to ascertain the amount of water used while running, or per I. HP. Extraordinary efforts should be made to prevent blowing off before train time and while running. The number of times and the length of time safety valve is blowing off should be recorded. No water should be taken from the tank for any purpose except supplying the boiler, and the boiler should not be blown off during a test if it can be avoided. If it cannot be avoided, the water should be at the standard height before and after blowing.

FORM B.

Locomotive Tests.—General Results.

.....Railroad Co.
.....Tests of Locomotive No...., between.....and
....
.....Bound. ....., ..., 18..
Distance,....Miles. Train No.....
Kind of Coal,..... Coal Analysis,.....
Calorimetric Value of Coal,..... .....
Trip No.
Date.
Left.... at.....
Arrived.... at.....
Left.... at.....
Arrived at.....
Weather.
Mean temperature of atmosphere.
Direction of wind.
Velocity of wind, miles per hour.
Condition of rail.
Size of exhaust nozzle, single or double.
Weight of train in tons of 2,000 lbs. (excluding the locomotive) tender, passengers and freight.
Weight of train in tons of 2,000 lbs. excluding the locomotive and tender.
Equivalent number of standard cars at.....tons each.
Maximum boiler pressure by gage.
Minimum boiler pressure by gage.
Average boiler pressure by gage.
Prevailing position of throttle.
Prevailing position of reverse lever.
Prevailing points of cut-off.
Schedule time in motion.
Actual time in motion.
Time made up in minutes.
Aggregate intermediate stops, minutes.
Time during which power was developed, or throttle open.
Average speed, miles per hour.
Maximum number of revolutions per minute.
Maximum rate of speed, miles per hour.
Maximum number of seconds per mile.
Actual weight of coal used.
Actual weight of wood used.
Average weight of coal burned per sq. ft. of grate per hour.
Number of miles run per ton (2,000 lbs.) of coal.
Number of pounds of coal used per mile.
Weight of ashes and unconsumed coal in firebox and ash-pan.
Weight of unconsumed coal in firebox and ash-pan.
Weight of cinders (sparks) in smokebox.
Weight of combustible utilized.
Percentage of ashes and unconsumed coal in firebox and ashpan.
Weight of unconsumed coal in firebox and ashpan.
Percentage of cinders in smokebox.
Percentage of combustible consumed.
Average temperature of feed water.
Weight of water drawn from tender.
Waste of injector.
Weight of water evaporated (39-40).
Actual evaporation per pound of total coal.
Equivalent evaporation from and at 212° per pound of coal.
Equivalent evaporation from and at 212° per pound of combustible.
Coal used per ton of train per 100 miles.
Coal used per car mile.
Water used per ton of train per 100 miles.
Water used per car mile.
Water used per hour while developing power.
Water used per hour per square foot of heating surface.
Water used per hour per square foot of grate surface.
Maximum indicated HP. developed.
Average indicated HP. developed.
Total coal per indicated HP. developed per hour.
Water evaporated per indicated HP. per hour. Dry steam used per indicated HP. per hour, per indicator diagram.
Percentage of moisture in steam.
Average number of sq. ft. of heating surface per indicated HP.
Average number indicated HP. per sq. ft. of grate surface.
Average temperature in smokebox while using steam.
Prevailing vacuum in smokebox while using steam.

Dynamometer Records.—The committee recommend that a dynamometer, when used, should be able to record not only the pull upon the drawbar, but also the speed of the train, the location of any point along the line used for reference, and possibly the wind resistance. The pull upon the drawbar should be shown by a continuous graphical record; and a scale of ¼-in. per 1,000 lbs. pull is recommended. The train speed should be recorded by an accurate chronometer furnished with an electric circuit breaking device operating at 5-second intervals. For very careful work some auxiliary apparatus like the Boyer speed recorder is advisable. It would also be desirable to have additional apparatus which would produce a continuous curve, the ordinates of which would represent the speed. The location of reference stations along the line is most easily recorded by having an observer operate an electric push button at the moment of passing such stations, the current operating to deflect sidewise a pen on the dynamometer diagram. Concerning wind resistance, the committee says:

Very little attention has so far been given to measurements of wind resistance, or the relation it bears to the frictional resistance of journals and wheels, and few experiments on this subject are recorded. The subject is very complex, owing to the fact that it is generally supposed, and we think with good cause, that the train is so very largely surrounded by eddies of air, and that it will be very difficult to obtain any reliable data, especially when it is remembered that the clearances of a railroad are greatly circumscribed and reduced to a minimum, so that it will be impossible to put any apparatus which measures resistance of this kind far enough out from the car to get reliable data. The apparatus for measuring this resistance would probably be subdivided into three separate disks, one facing front and two facing toward the sides of the car, all three connected together to produce a single resultant curve drawn upon the diagram paper, and the scale upon which this is drawn could probably be best subdivided into ten points, as practiced by the United States Government.

Further recommendations as to dynamometer records are that it is of great advantage to have more than one relative speed of the paper on which the diagrams are recorded so that it can be moved, for instance, at the rate of 1 in., ½ in. or ¼ in. per 100 ft. of motion of the car. All the registering pens should be on one line transverse to the direction of the paper. To work the dynamometer, one chief and one outlook are necessary, and an assistant to look after the working of all the mechanism of the car is advisable.

Steam Calorimeters.—There is little doubt that the superheating or throttling calorimeter will fulfill all requirements for testing the dryness of steam in locomotives. It cannot measure quantitatively more than about 5% of moisture, but it appears probable that locomotive boilers develop steam which either contains a fraction of 1% of moisture, or the priming is a sudden temporary action, causing water to mix with the steam to such an extent that no quantitative measurement of its amount is practicable. Under these circumstances all that is desired of a calorimeter is to indicate the temporary occurrence of this sudden excessive priming, and a throttling calorimeter has been shown by Mr. D. L. Barnes to be capable of doing this, provided the

thermometer has its bulb in direct contact with the steam flowing through the calorimeter. Such an arrangement is shown in Fig. 4, of which the following is a description abstracted from the "Railroad Gazette" of Nov. 27, 1891:

This instrument (Fig. 4) consisted of two pieces of brass pipe, one inside of the other, leaving an air space between the outer and the inner. The outer pipe was screwed into the dome and extended within the dome to the throttle. At this interior end the two pipes were joined together by a cap which had a perforation 3-32 in. in diameter. On the outer end of the inner pipe was placed a globe valve, and next to this and outside of it a tee in which was a stuffing-box and a thermometer, as shown by the sketch herewith.

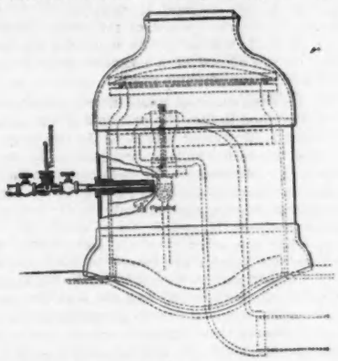


Fig. 4. Calorimeter Attached to Steam Dome.

Beyond this tee was another globe valve and a short pipe of large diameter to carry the steam jet away from the man in charge.

With this device the point of most rapid movement of the steam was located next to the throttle, and any water coming near it would immediately pass through the opening, because of the high velocity. The thermometer bulb was bared to the steam, and no cups were used. It was found possible to shut off the outer globe valve and expose the thermometer to a full boiler pressure without blowing the thermometer from the stuffing box. In this way it was determined that the thermometer recorded a steam-temperature which corresponded to the steam gage in the cab.

With this instrument priming was shown whenever the boiler was filled to a point where water could be seen coming from the stack. Immediately when the boiler foamed, the thermometer in the second calorimeter dropped to 212°. It is believed that this calorimeter is more accurate for locomotive work, because it often happens that the locomotive primes only at starting and not for a sufficient length of time to enable the Barrus instrument to make a true record. And again, there are in a locomotive rapid changes in the rate of steam use which must cause rapid changes in the wetness of the steam.

The questions yet to be settled regarding the instrument are: 1. From what part of the interior of the boiler should it draw its steam? 2. Can the thermometer be located in the cab? We think it probable that the pipe leading from the interior of the boiler can be steam-jacketed so as to maintain the steam carried to the throttling valve of the calorimeter at boiler pressure, but a trial of such an arrangement has yet to be made. We think, also, that calorimeters must draw steam both from dome and from the pipe carrying steam to the cylinders nearly at its exit from the boiler, in order to determine fully the performance of the boiler as a generator of dry steam. Of the two locations, we regard the end of the steam-pipe as best fitted to represent the quality of the average output of steam.

As stated at the beginning, this is a preliminary report, and is subject to revision. In our final report we expect to include some of the results obtained in shop tests of locomotives by Prof. Goss, and some comparative tests of simple and compound locomotives.

William Forsyth, F. W. Dean, J. W. Cloud, A. S. Vogt, Allan Stirling, J. E. Denton, R. H. Soule.

PROGRESS IN STEEL CAR CONSTRUCTION.

As we have often said before, we look upon it as a practical certainty that, just as iron and steel have displaced wood in ship-building and bridge-building, and to a large and increasing extent in house building and other structural work, they will in the end displace wood in car construction and as a material for cross-ties. It is only a question of time. Wooden cross-ties will continue to have the preference for ordinary track throughout the United States for a long time to come, but steel ties are beginning to be used where specially good track is required, and as the timber supply becomes exhausted there is certain to be an increasing demand for them.

The advantages promised by substituting steel for wood in car construction, however, are relatively very much greater, and hence the process of substitution is likely to go on very much more rapidly. In fact, there are already, it is claimed, over 15,000 iron and steel cars now in service on this continent, and in the main giving a very good account of themselves. One of the oldest of these designs which has attained prominence is the so-called tubular car, largely built of iron tubing, full details of which were given in our issue of April 28, 1892, and various earlier issues of the past six years. We regret to say that this company is obstructed by some financial difficulties at present, but no doubt these will be overcome, and the construction of cars continued with all necessary improvements of design which experience has indicated.

In our issue of July 11, 1891, we gave full illustrations and description of the Harvey steel stock car (60,000 lbs. capacity), which is certainly one of the best, or possibly the best, design as yet brought forward, and which has recently been one of the most successful. While it is not wise to be very dogmatic about such matters, it strikes us that plates, angles and I-beam sections, rather than tubes or other special forms, must necessarily give the easiest, cheapest and most effective mode of using steel in car construction, after trade conditions have once adjusted themselves to such construction. It is obvious that, if it is possible to build and sell steel cars now (which is a demonstrated fact), it must grow more and more easy to do so with time, for the price of timber suitable for car-building must tend to rise, and the price of steel and iron must tend to fall, both as an effect of general progress in the arts and of enlarged demand. If it be true, as claimed (and it seems a moderate claim) that for $100 more cost or thereabouts a car 15% lighter for equal strength can be furnished, that alone makes the car economical, apart from the questions of greater durability, stronger draw-gear attachments, etc., as we have pointed out on another page.

The Harvey works are now becoming quite extensive, as the following facts will show, gathered at a recent visit to the works. The main shop is 100×300 ft. two stories high, with iron roof trusses. There are three through tracks in it. One side is occupied by steel-working machinery, a 100 HP. Corliss engine, two Wicks Bros. boilers, etc.; the other side is used for erecting steel cars and making repairs. The works will soon make its own tools, as a tool-room is being fitted up. Fuel oil is used to run the bolt manufacturing machinery, and is to be used for running some of the other machinery. The oil is furnished by the Standard Oil Co., in tank cars, and pumped from a tank of 6,000 gallons capacity to a furnace, 4 ft. wide, 18 ft. long, 12 ft. high. The cost of the oil is 50 to 60 cts. per bbl.

The wood-working shop is 80×200 ft., two stories high, all wood. It is filled with machinery of the latest designs, but without special novelty, unless it be a new 16×24-in. sill dresser (from the Benjamin Machine Co., Chicago), built to plane an inch deep if necessary from each of two sides at one cut. This machine is giving good satisfaction. Power is furnished to a 100 HP. compound Westinghouse engine from the erecting shop through an elevated steam pipe. A system of condensation, designed by the Westinghouse Co., is being used with good results.

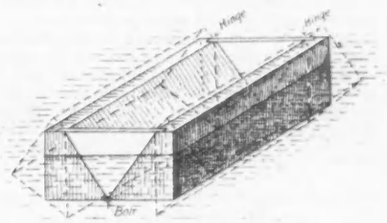
A new erecting and repair shop, 80×300 ft., to have four through tracks, is being erected near the car shop. Facilities for making all kinds of repairs have been provided, and about 100 cars are being repaired monthly for the United Tank Line Co. alone. Among the other users of these cars are the Chicago & Erie, Hutchinson Refrigerator Car Co., Western Rolling Stock & Equipment Co., American Cotton Seed Oil Co., and others. About 25 34-ft. stock cars, similar to the car illustrated in Engineering News of July 11, 1891, have been lately built for the Chicago, Milwaukee & St. Paul R. R., and, so far as we can learn, all those in use are giving excellent satisfaction. The Illinois Steel Co. has had 12 of the Harvey cars in use a year and a half, and it is reported that no repairs whatever have been required as yet.

The works are located at Harvey, Ill., just out of Chicago, and are connected with the Grand Trunk Ry. and the Illinois Central, and they will also shortly connect with the Chicago & Calumet Terminal Ry. There is in all nearly four miles of track running through the works at present, with frequent additions. Altogether it is undoubtedly the most complete steel car plant in the world, and, as such, a gratifying sign of progress. Mr. J. D. McIlvain, the superintendent of the works, is a well known member of the Master Car Builders' Association, having served on several of its committees, and was formerly superintendent of the Grand Trunk Ry. car works at London, Ont.

DUMP SCOW FOR SHALLOW WATER.

We have received from Mr. Henry A. Gray, of Toronto, Ont., engineer in charge, Department of Public Works of Canada, a description of a form of dump scow adapted for use in shallow water. We give the description in Mr. Gray's own words, but he does not state that the scow has been actually in service:

For many years I have been trying to do away with the doors that are used in the ordinary dump scows and which require a greater depth of water than the scows draw, when loaded, to dump in and float the scows over the load after dumping. The arrangement shown in the sketch consists simply of two floats



A Dump Scow for Shallow Water.

Full lines show pocket closed to receive material.
Dotted lines show pocket open in the act of dumping.

fastened together at the bottom with bolts when being loaded, forming with the two doors, which are hinged to the floats on top, a pocket for the reception of the dredged material. To dump the material the bolts are withdrawn and the weight of the material, in the pocket, forces the floats apart at the bottom, and the material falls out.

Where clay or other sticky material is dredged, it will not adhere to the sides of the pocket, as in the ordinary dumping scows, as the sides of this pocket become perpendicular when in the act of dumping. The end doors fit into grooves in the floats when closed. Engineers and contractors, who have carried on dredging operations in shallow water and have had to dump in the same, will appreciate my design. The floats can be calked with much greater ease than the ordinary scows.

THE MEASUREMENT OF POWER. (a)

One of the most important, and at the same time most troublesome, problems in mechanical engineering is the measurement of the power produced by a motor or given to a machine. In this paper a brief description is given of the principles of three forms of dynamometer which have been used for this purpose with fairly successful results.

I. Fig. 1 illustrates a form of dynamometer which may be used either to measure the power given to any machine, as, for instance, a dynamo, or to measure the total power given out by an engine which is driving a number of machines. Suppose that (B) is the crank shaft of an engine. A cross-head such as, for a different purpose, is here represented by (J), is keyed to the shaft, and the pulley (P), which in this case is the driving pulley, is connected to the shaft by means of four links (E, M, F, N) connecting the cross-head to a pair of double bell crank levers (K L O) and (C D G), mounted on bearings fixed to the pulley. The ends of the arms (O) and (G) bear against one end of a rod (R) passing along the axis of the hollow shaft of the pulley. When the shaft (B) is turned, two of the arms of

(a) A paper by Thos. Gray, Prof. Dynamic Engineering, Rose Polytechnic Institute, presented at the San Francisco meeting of the American Society of Mechanical Engineers.

the cranks,as (F) and (M) or (E) and (E),are pulledtoward the cross-head, and thus tend to push the rod (R) outward. This is resisted by the bell crank lever (S), which is supported by a plate resting on a diaphragm which closes the top of the cylinder (T). The cylinder (T) is either partly filled with mercury and partly with water or filled with water and piped to a mercury or other form of pressure gage placed in any convenient position. The pressure on the end of (R) is thus resisted by a column of mercury the height of which will be directly as the pressure and inversely as the size of the plate resting on the diaphragm. Thus by

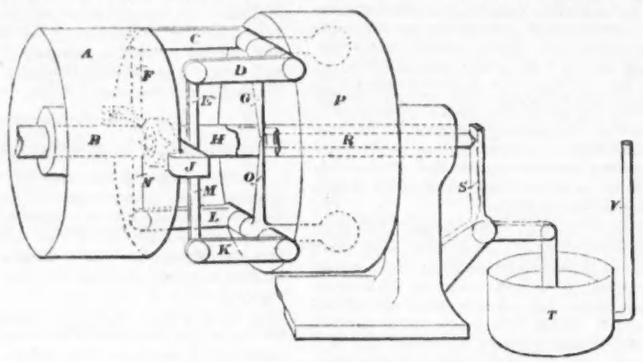


FIG 1. SHAFT DYNAMOMETER.

finding the indication of the gage when a known pull or push is applied to (S) at the point of contact of (R), the turning moment exerted by the engine can be calculated for any value of the reading on the gage. The effect of centrifugal force on the levers attached to the pulley (P) must be eliminated, and this is done by counterpoise masses applied as indicated by the dotted lines inside the pulley. When the speed of the engine is known, the indications of the pressure gage give the

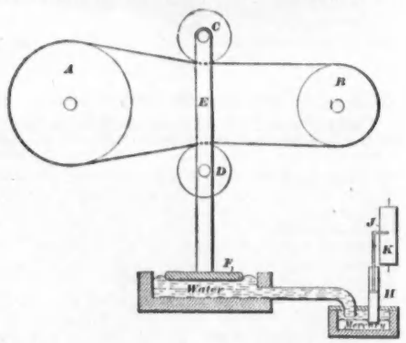


Fig 2. Dynamometer Operated by Differential Tension of Belts.

means of determining the HP. being transmitted at any instant. When a record of the variation of the resistance which the engine experiences is required, the tube (V) is provided with a float carrying a recording pin, and a record drum is mounted and driven either by clockwork or by the engine itself. In case like those of electric street car service very interesting and instructive records are thus obtained, showing the

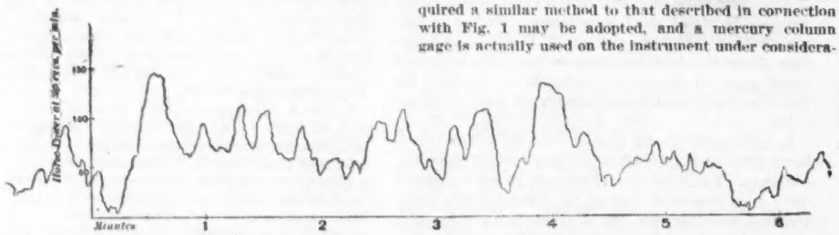


FIG. 3. DYNAMOMETER DIAGRAM FROM ENGINE DRIVING TERRE HAUTE ELECTRIC STREET RY.

maximum power required and the fluctuations of power which occur in such service. The area of the record between the zero line and the line drawn by the recording pin is proportional to the whole work done in the time during which the record is made. This area can be very accurately and quickly obtained by cutting it out and comparing its weight with that of the same length of the whole breadth of the paper ribbon. A better method of mounting the dynamometer as an energy meter is to mount a light counter on the float and allow one wheel of the counter to be driven by contact with the face of a disk which is driven by the engine. The friction wheel of the counter should be on the center of the disk when no work is being transmitted. In the designs of the dynamometers built for use in the shops of the Rose Polytechnic Institute both the recording pin and the integrating apparatus have been included, but the integrator has not yet been attached to any of them. Arrangement can very easily be made in this particular form for checking the zero, as the thrust of (R) can be easily taken up by a collar, leaving (S) free and thus bringing the pin and friction wheel to zero.

When the dynamometer is used to measure the work given to any particular machine, (P) becomes the pulley driven by the belt, and (A) the pulley of the machine. The cross-bar (J) is clamped to the pulley, and the action is the same as that just described.

II. Another form of dynamometer which has been

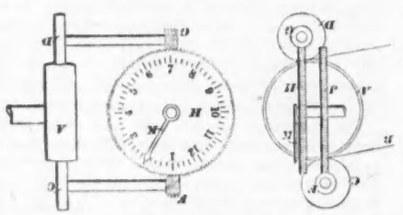


Fig. 4. Dynamometer Operated by Elastic Creep of Belts.

used with good results is illustrated diagrammatically in Fig. 2. In this case let (A) be the driving and (B) the driven pulley. Two pulleys, (C) and (D), are mounted on a frame (E), and properly supported, so that they can be pulled together on the belt. The frame (E) is supported by means of a plate (F) resting on a diaphragm as shown. The whole weight of the frame together with the weight of the deflected belt should, however, be independently supported, so that a change of length of the belt while running does not affect the indications. The water under the diaphragm transmits any change of pressure on the plate (F) to the pressure gage, which, as in the case above described, may be of any ordinary form if a record is not required. When a record is required a similar method to that described in connection with Fig. 1 may be adopted, and a mercury column gage is actually used on the instrument under considera-

tion. The lower belt being supposed the driver,it becomes tighter and the upper slacker as the power increases; thus greater pressure is thrown on the plate (F). This, however, does not sensibly change the positions of the pulleys or the deflections of the belt, which must be stretched sufficiently to prevent the upper half of the belt becoming slack when the maximum power is being transmitted. This apparatus may be standardized statically by placing a weight on the belt above the pulley (D), but when possible it is better to standardize it by causing the machine to do a known or measured amount of work. In many cases this can be readily done by means of a brake. In the case of electrical machinery a definite increase of work may be obtained and measured electrically.

A part of a diagram of work taken from a test of the Terre Haute electrical street railway is given in Fig. 3. This diagram is interesting as showing the extremely rapid variation of the power which the engine was called upon to deliver, and the promptitude with which the call was responded to by the belt. Variation of speed is not taken account of here, as no separate time marker was placed on the apparatus. The time scale marked on the diagram is therefore to be taken as simply the average speed of the paper. The diagram here shown is similar to the remaining portion, which contains the record of a complete day's work and is therefore of considerable length.

III. Perhaps the most interesting of the dynamometers here described is that the principle of the arrangement of which is illustrated in Fig. 4. In this figure (B) represents the belt which is supposed to be driving the pulley (A). Bearing on the belt and just clear of the pulley two measuring wheels (C) and (D) are fixed. These measuring wheels communicate their motion to two counting wheels (H) and (J) one of which, (H) carries a dial, while the other carries a pointer (K). Both the dial and the pointer are turned in the same direction, so that if both pulleys (C) and (D) make the same number of turns, the pointer (K) and the dial (H) turn at the same rate. When the belt is called on to transmit work, however, the tight side of the belt runs faster than the slack side on account of its smaller section. What is commonly known as the elastic creep of the belt is increased and hence one of the pulleys makes a greater number of turns per minute than the other. Either the dial or the pointer goes ahead, and the rate of gain is proportional to the rate of working, while the total gain in any time is proportional to the total work done in that time. This dynamometer, as it has been made for laboratory use, has provision for adapting the distance between the pulleys (C) and (D) so as to fit any size of pulley (A) up to six ft. diameter. The whole is mounted on a shaft, which, when the machine is in use, forms a continuation of the driven shaft, while (F C) and (G D) are carried by arms which allow the counting wheels to be placed at different angles apart on the driven pulley. The object of this is to enable the gradual increase of speed of the belt as it passes from the slack to the tight side to be illustrated. In this particular dynamometer there is a double worm and gear reduction between (C) and (J), and between (G) and (H), which causes 2,500 turns of the counting wheels to give one turn of the dial and pointer. 1% of creep thus causes the relative motion of the dial and index to be one turn for 250,000 turns of the wheels (C) and (D). With wheels 1 ft. in circumference, and a belt speed of 5,000 ft. per minute, which is nearly the actual case for one of our dynamos, we got one turn of the index on the dial in 50 minutes. Full power gives considerably more than this, and therefore for continuous working the speed of indication is fast enough. For a power indicator with slow speed belts the reduction is too great, as in this case it should be possible to measure the work done in one minute accurately. For such purposes it is intended to put on a steady deflection indicator worked by the counting wheels. Suppose, for example, an axis driven by (C F) and carrying a wheel turning with the shaft, but free to move sideways. Let this wheel run in contact with the face of a disk driven by (D G). The wheel will move to the position on the disk where there is no slip, and it can therefore be made to turn a pointer and indicate the rate of working at any instant.

No attempt has been made to give details of construction. The object has been simply to point out the principles on which these dynamometers act; any one wishing to use similar devices will readily supply the details of construction suitable for his particular case. I have to express my obligation to my colleague, Prof. Ames, without whose assistance in preparing the diagrams I could not have found time to present these papers.

DRY DOCK FOR THE U. S. NAVAL STATION AT PUGET SOUND, WASHINGTON.
(With inset.)

As noted in our issue of April 28, the government has decided upon the construction of a dry dock on the Pacific coast, the location to be at the Puget Sound Naval Station. The plans and specifications have been prepared by Mr. M. T. Endicott, of the Bureau of Yards and Docks, U. S. Navy Department, and provide for a timber dry dock of a form recently patented by Mr. Endicott. In former issues

we have illustrated and described some of the Simpson timber dry docks, including those at Brooklyn, May 10, 1890; League Island, March 14, 1891, and Newport News, May 16, 1891; while in our issue of Oct. 31, 1891, we illustrated and described a large timber dry dock at Detroit, Mich.

The special features of the patented form of construction are shown in Figs. 1 and 2, which are reproduced from the drawings accompanying the patent specifications. As shown in these illustrations, piles are used when the material underlying the dock is of a yielding nature. These are cut off at a proper level, and upon their tops are secured the longitudinal timbers (A). The soil about the heads of the piles is then excavated, and a system of perforated or porous drain pipes (B) is laid down, the drains intersecting at convenient regular intervals. A mass of concrete is then rammed into the space above the drains, and longitudinal drainage gutters or culverts (C) formed in the concrete, preferably in the center of each half of the dock, or at the sides, near the altars. Transverse timbers (D) are then laid down and secured to the timbers (A), and concrete is then rammed between the timbers (D), sloping from the top of these timbers at the sides to half their depth at the middle of the dock. The longitudinal drains are connected with a larger drain, leading to the pump well. The purpose is to provide a complete system of drains, all connected and leading to the main pump-well, and thus relieve the floor of the dock and the base of the altar system, within the sheet-piling (E), from hydrostatic pressure of water, tending to force it up or cause leaks. It also avoids the use of the vertical relief valves usually employed along the culvert, and the horizontal flap-valves on the sides.

The sides of the dock are constructed as shown in Fig. 1. The inclined timbers (F) are secured to the heads of the inclined piles (G), previously driven, and also to the cap timbers and piles at the bottom and the transverse timber (A). The object in driving the piles (G) on an incline is to bring them more nearly in the line of the strains upon them, either from the thrust of shores from the ship, or from the hydrostatic pressure of water, in front or rear, when the dock is full. The manner of attaching the altars is shown in Fig 2, and the space behind these altars is filled with clay, puddle or concrete, as seems best. Drains have been used before in masonry dry docks, so Mr. Endicott only claims the application to wooden dry-docks, as here described.

The soil at the site of the Puget Sound dock consists of sand and gravel, with some clay and a little hardpan. The bottom of the dock will be principally on sand. The dock will be built of timber and concrete, with entrance works of concrete and stone masonry. The entire structure will be founded upon piles, unless during the progress of the work it is found better to substitute a mass of concrete for the piling under the floor. The culverts and pump well will be of good hard burned brick laid in cement mortar and concrete. There will be a one-story engine, pump and boiler house, of brick with stone trimmings, and having steel roof trusses and a slate roof. The three pumps will be of the centrifugal type, balanced and driven by vertical, high-pressure, non-compound engines, steam being supplied by six horizontal, return tubular, steel boilers. The caisson, or floating gate, will be of steel, and fitted with an engine, pump and boiler. The plan of the dock is shown in Fig 3, and the general construction in Fig. 4. The principal dimensions are as follows:

	ft.	ins.
Length on coping; head to outer end of table	625	3
" " " head to outer gate	605	9
" on floor; head to inner abutment	529	3
Width on coping; at body	130	1½
" " at abutment	92	7½
" on floor in body	67	1½
Depth, coping to mean high water	7	0
" coping to floor in body	39	3
Draft over sill at mean high water	30	0

All piles are to be of Douglas fir, not less than 12 and 6 ins. in diameter at the butt and top respectively. They are to be shod with iron if considered necessary by the engineer, and those which are to be in contact with concrete or clay puddle must have the bark removed from such surfaces of contact. Piles for the bottom of the dock must be driven to a satisfactory depth, at least 18 ft., and to a set of ¼-in. under the last blow of a 3,000-lb. hammer falling 25 ft., or the equivalent thereof. Sheet piling is to be of the same timber, 5 ins. thick, about 10 ins. wide, grooved and fitted with cedar tongues 1¼ × 2 ins., and driven close. At the intersections of rows of sheet piling, piles 12 ins. square, and properly grooved are to be driven. After the piles in the dock bottom, inside the abutment floors, are driven, and excavations made for the concrete, longitudinal and transverse sub-drains 6 × 6 ins. inside are to be made of 2-in. planks, and connected at all intersections. The sides of these drains are to be perforated with three 1½-in. holes per lin. ft. A filling of gravel or broken stone will be laid around the drains, and they will be entirely covered by the concrete. The longitudinal sub-drains will empty into drains leading into the pump well, and have flap valves at their outlets. The heads of the foundation piles are to be surrounded by a continuous bed of concrete at least 3 ft. thick and extending up the sides of the dock to the foot of the eighth altar, as shown in the cross section Fig. 5. There will be drainage gutters 3 ft. wide with a fall of 20 ins. toward transverse drain, for under-floor drainage, and the concrete at the transverse drain is to extend 5 ft. lower than in the body of the dock. The concrete will be composed of 1 part Portland cement, 2 parts sand and 4 parts gravel. The cement and sand will be mixed dry and then made into a paste with water and spread over the gravel, which will have been previously moistened and spread in an even layer on the platform. The mass will then be turned over three times, deposited in layers of 9 ins. thickness, and rammed until water appears upon the surface. The top of each layer will be moistened before the next layer is placed upon it, and if it has been long exposed is also to be dusted with neat cement. The Portland cement is to have a tensile strength of not less than 400 lbs. per sq. in., after being exposed one day in air and six days in water.

The stone masonry is to be of granite or sandstone ashlar in continuous courses of 2 ft., with ¼-in. joints, laid in Portland cement mortar of 1 part cement to 2 parts sand, and pointed with 1 to 1 cement mortar. The coping stones are to be 2 ft. thick, 4 ft. wide and 4 ft. long. The culverts, Fig. 7, will be of concrete and sewer bricks laid in Portland cement mortar, 1 part cement to 3 parts sand. The cross section of masonry at entrance is shown in Fig. 6. The timber work of the dock will be of Douglas fir. The floor system will consist of 12 × 12-in. longitudinals upon the piles, with transverse timbers 14 × 16 ins., spaced 4 ft. c. to c. Upon the transverse timbers will be laid the 3-in. working floor with open joints. The brace timbers will be 10 × 14 ins., and the cross caps 12 × 12 ins. The altars will be 11 ins. rise and 9 ins. tread. The diagonal tie timbers will be 5 × 10 ins. A timber coping, built up of three timbers, will be constructed as shown. There will be three slides on each side, and one at the end, for sending down materials, and these will have floors 3 ins. thick. Clay puddle is to be rammed down behind the altars to a depth of at least 2 ft. from the lower side of the braces. The keel blocks, bilge blocks and bilge block sides will be of oak, and fitted with racks, keys, pawls, slides, chains, etc. All the timber work is to be put together with the best quality of refined American iron bolts, spikes, etc. The connection between the timber body of the dock and the masonry entrance will be made by an extension of the concrete in the abutments, and suitable iron tie bars, to embrace not less than three of the altar brace timbers. This work is also to be thoroughly grouted as the altars are laid up.

The caisson or floating gate will be a double ended hull, with an upper deck of wood, a main and lower deck of steel, both water tight, and two sets of beams without a deck. It will be built of steel, and the construction is clearly shown by Fig. 8. The length over all, at top of water ways, is 94 ft. 10⅜ ins.; extreme molded breadth, 24 ft.; molded breadth at top, 13 ft.; extreme height, from bottom of keel to top of water way, 38 ft. 11¼ ins. The gate packing will consist of a 6 × 10 in. creosoted fir timber, with a rubber packing secured to it by copper nails, and the exposed surface of the timber will be covered with sheet copper or studded with copper nails. There will be twelve valves and filling culverts, 20 ins. diameter, for letting water through the caisson into the dock, and two sluices 20 ins. diameter connecting the water chamber between the watertight decks with the harbor, for letting the water ballast into the caisson. The steel plates, angles and slopes are to have a minimum tensile strength of 60,000 lbs. per sq. in., an elongation of 25% in 8 ins., and specimens must stand a cold bending test of bending over flat on themselves without sign of fracture. The rivets are to be of wrought iron, 55,000 to 60,000 lbs. per sq. in. tensile strength, and 45,000 lbs. average shearing strength. The bottom will be filled with concrete, and movable ballast of pig iron will be provided to give the necessary stability. The caisson will be fitted with a centrifugal pump, driven by a windlass engine, with a discharge capacity of 2,500 gallons per minute with the greatest lift.

The pumping plant of the dock will consist of three centrifugal pumps for pumping out the dock, with separate and independent engines, and one centrifugal pump and engine. The pumps will admit water on both sides of the disks, which will be 68 ins. diameter, with 42-in. suction and discharge pipes. The engines will have cylinders 24 × 28 ins. There will be six cylindrical, horizontal steel return tubular boilers, externally fired. They will be 16 ft. diameter, 16 ft. long, with 80 4-in. tubes, and grates 7 ft. long. The plant is to have a mean discharge duty of 110,000 gallons per minute, with a boiler pressure of 100 lbs. per sq. in. The drainage pump will have a 34-in. runner, with vertical high pressure engine with cylinders 12 × 12 ins., and the suction and discharge pipes will be 14 ins. diameter.

AN EXPERIMENTAL LOCOMOTIVE.

In the engineering laboratory of Purdue University at Lafayette, Ind., a full-size locomotive has been erected, for purposes of experiment and instruction. Its driving wheels rest on supporting wheels, permitting the drivers to be turned either forward or backward; and by means of brakes on the supporting wheels the locomotive may be given any desired load up to the limit of its capacity. At the current meeting of the American Society of Mechanical Engineers a paper describing the locomotive and its mounting was presented by W. M. F. Goss, Professor of Practical Mechanics, from which we take the accompanying illustrations and abstract the following description:

The locomotive was built by the Schenectady Locomotive works. It is of the 8-wheel type, with 17 × 24-in. cylinders and 63-in. drivers. Its weight is 85,000 lbs., of which 56,000 lbs. is on the drivers. The supporting wheels on which the drivers turn are of the same diameter as the drivers and similar in construction. They are flangeless and have flat tires with the inner edge rounded like a rail section. The shafts for the supporting wheels are of forged iron and rest in bearings 8 ins. in diameter and 16 ins. long. These bearings are supported by a cast iron plate 14 × 36 × 2 ins., bedded on a framework of oak timbers, 14 ins. thick. The timbers rest on a foundation of rubble masonry 5 ft. deep.

Figs. 1 and 2 show an elevation and plan of the mounting. The principal features of interest in connection with the apparatus are the friction brakes on the shafts of the supporting wheels, by which the work done by the locomotive is absorbed, and the dynamometer, by which the traction pull of the locomotive is measured.

The friction brakes are intended only for the absorption, not for the measurement of the power exerted. They are designed on the principle developed by Prof. Geo. I. Alden, of Worcester, (Vol. XI., p. 959, Trans. Am. Soc. M. E. Also Eng. News, June 28, 1890). This principle consists in the employment of annular disks, thoroughly lubricated, as the rubbing surfaces, and forcing them together by hydraulic pressure.

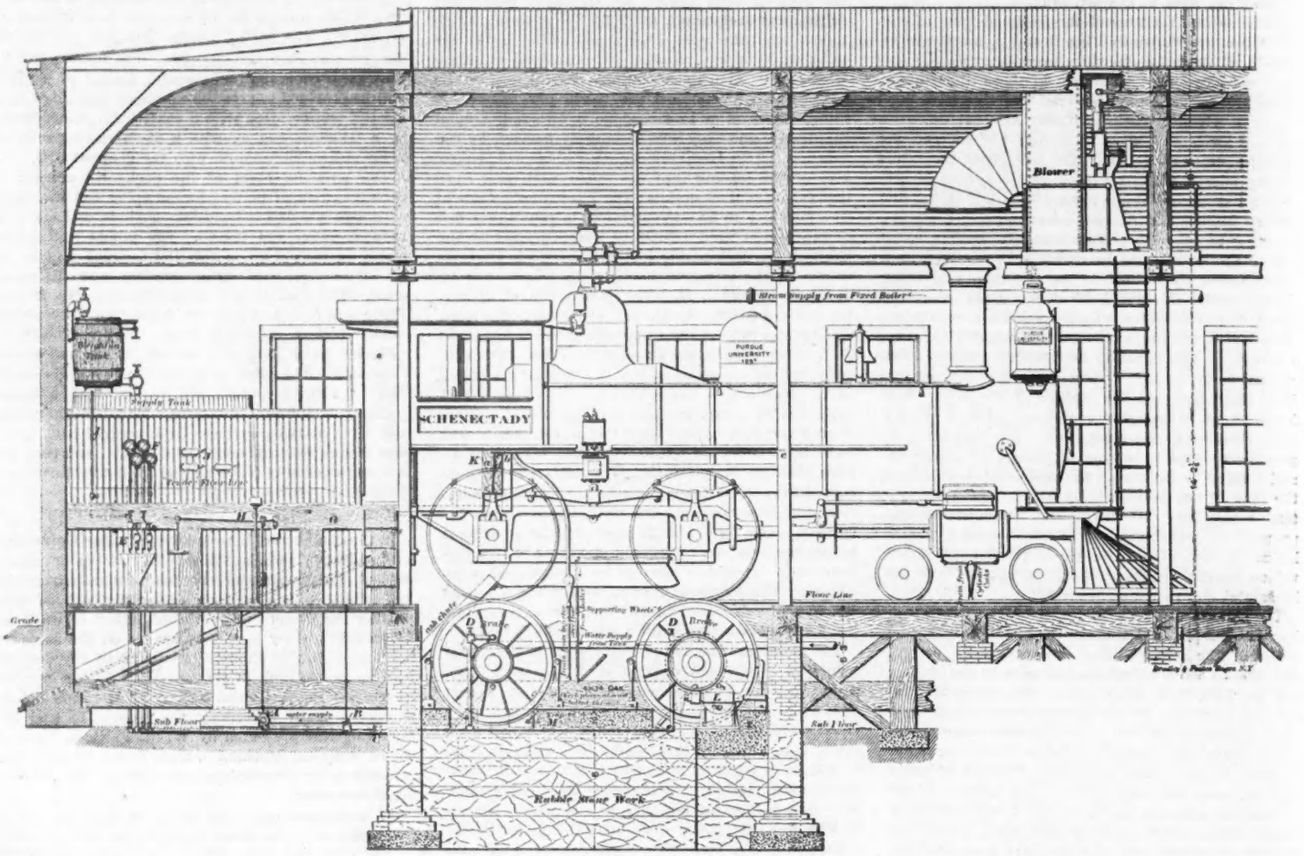
The details of the brake are shown in Fig. 3, and its construction is described as follows:

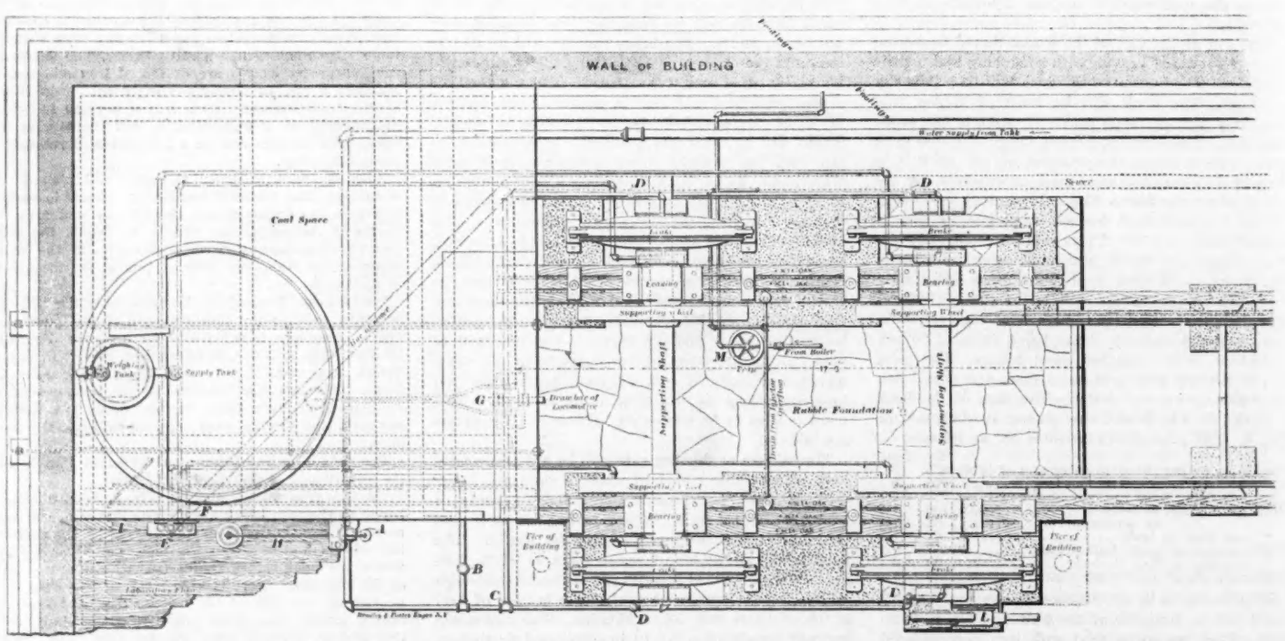
The cast iron moving disk K (Fig. 3, Section AB,) is keyed to the supporting shaft. The power of the locomotive is transmitted from the drivers by the supporting wheels and shaft to the disk, on either side of which are light copper plates (L), which form a part of the enclosing case. The sides (M) of this case have bearing on the hub of the moving disk and are connected around their outer edges by the distance ring (N), and by through bolts (Section CD). The copper plates are clamped at their outer edges between the sides of the case and the distance ring (N). At their inner edges the joint is made by means of wrought iron rings, secured by closely-spaced machine screws tapped into the case. The copper plates are thus held very near to the moving disk but they are not necessarily in absolute contact with it. Between the copper plates and the sides of the case are annular spaces (P), within

which water may be circulated. It will be seen that the case with its copper plates is quite free to revolve upon the hub of the cast iron disk; or if, as in practice, the case is at rest, the disk may revolve freely within it. It will be seen also that water under pressure in the annular spaces (P) will force the light copper plates against the moving cast iron disk; that, as a result of this contact, there will be a tendency on the part of the case to turn with the cast iron disk, and that if this tendency be overcome by an outside resistance, power will be absorbed. This, in brief, is the action of the brakes; the case, in the present instance, is prevented from turning, by anchor rods connecting it with the foundation (Figs. 1 and 3).

The circulating water enters at the opening (Q), (Fig. 3), passes from the annular space on this side of the case to that on the other side by eighteen ⅝-in. holes through the copper plates and the distance ring (Section EF), and is finally discharged at the opening (R), sufficient water being allowed to pass to carry away the heat resulting from the friction. To prevent the water pressure within the brake from spreading the sides of the case, the rings S are fitted over a feather to the hub of the moving disk, and are held to their place by nuts which screw up to a shoulder.

When the brake is in use, all clearance space between the copper plates and about the moving cast iron disk is filled with oil. The distribution of the oil is secured by 32 radial grooves on each face of the cast iron disk (Fig. 3), and by a spiral groove extending from the inner edge to the circumference of the rubbing surface of the disk, with a pitch of about 4 ins. The entire rubbing area of the cast iron disk is thus split up





FIGS. 1 AND 2. MOUNTING OF EXPERIMENTAL LOCOMOTIVE IN ENGINEERING LABORATORY OF PURDUE UNIVERSITY, LAFAYETTE, IND.

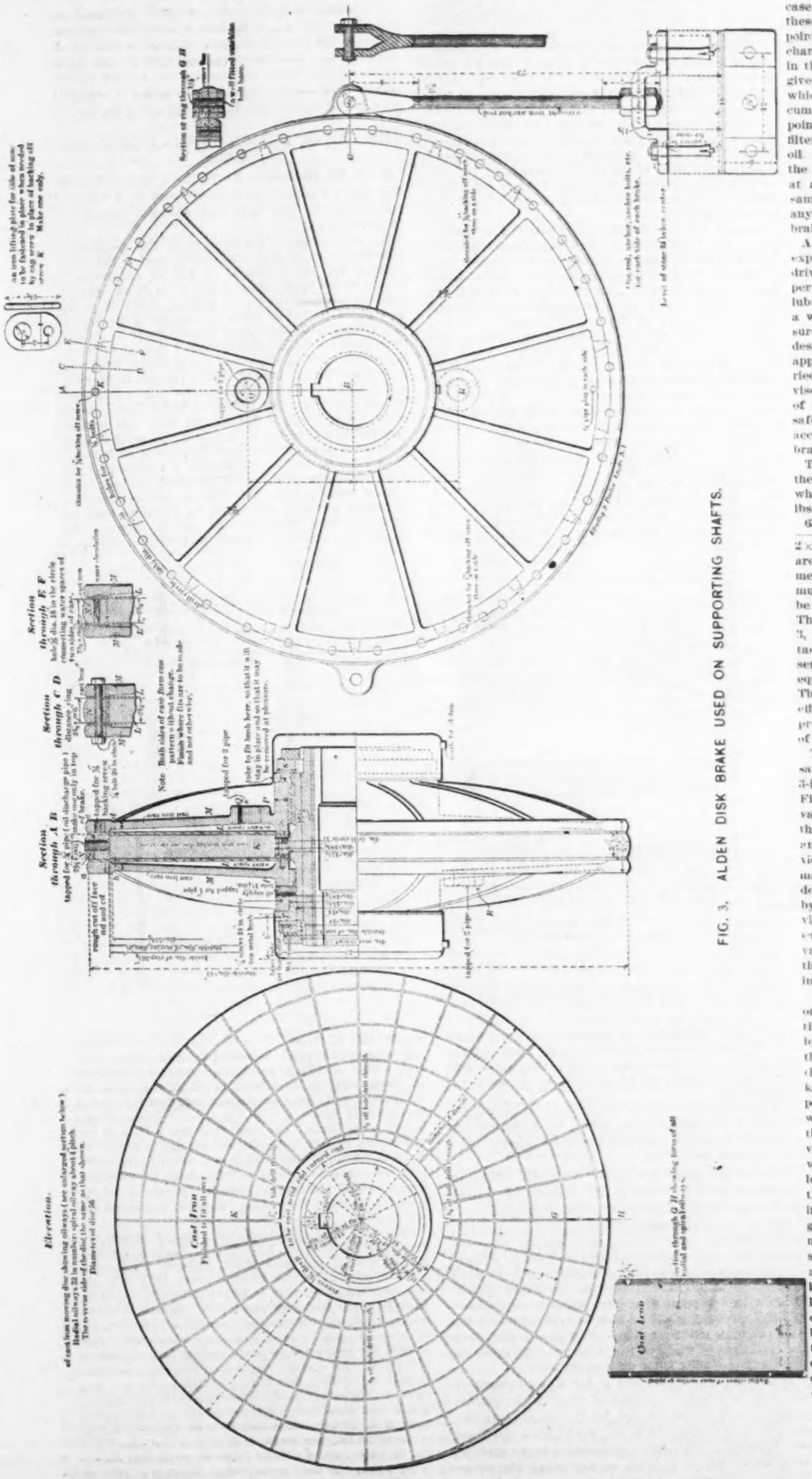


FIG. 3. ALDEN DISK BRAKE USED ON SUPPORTING SHAFTS.

into surfaces, the length or breadth of which in no case greatly exceeds 4 ins. The spiral oil-way gives these surfaces a position such that in passing a given point on the copper plate their alinement is continually changing, which fact, it is believed, greatly assists in the distribution of the oil. The radial grooves also give rise to a slight pumping action, by means of which the oil is kept in circulation between the circumference and center of the brake. From the highest point of the brake the oil is delivered by a pipe to a filter can, which also serves as a supply reservoir, the oil after filtering being led from it to the center of the brake. This circulation helps to maintain the oil at a uniform temperature, subjects all parts to the same service, and gives a ready means for detecting any defect which may arise in the lubrication of the brake.

As preliminary to the design of these brakes, some experiments were made on a 21-in. disk brake while driven at speeds varying from about 300 to 450 revs. per minute, from which experiments it appeared that lubrication could be maintained with certainty under a water pressure of 40 lbs. per sq. in., and this pressure was adopted as the maximum to be used in the design of the larger brakes herein described. It also appeared that the apparent coefficient of friction* varied from 2.7% to over 4%; depending largely on the viscosity of the oil used and upon the temperature of the brake. It was thought that 3.5% would be a safe coefficient for moderate speeds, and this factor was accordingly used. It was also decided to use four brakes in preference to two.

The locomotive drivers are 63 ins. in diameter, and the sum of the moments about the two driving axles when the engine is exerting a tractive force of 16,000 lbs. (assumed to be the maximum) is therefore $16{,}000 \times \frac{63}{2 \times 12} = 42{,}000$ ft. lbs. which, since the supporting wheels are of the same diameter with the drivers, is the moment under which the brakes on the supporting shaft must work. Each of the four brakes, therefore, must be capable of acting under a moment of 10,500 ft. lbs. The disk of the brakes constructed, and shown by Fig. 3, is 56 ins. in diameter. The area in effective contact with the copper plates on either side is represented by an annular surface having its outer radius equal to 28 ins., and its inner radius equal to 10 ins. These dimensions, in connection with the assumed coefficient of friction and the assumed maximum water pressure give a calculated moment slightly in excess of the required 10,500 ft. lbs.

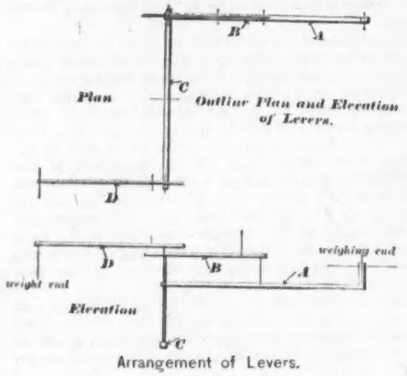
The water supply which cools the brakes and at the same time regulates their resistance is furnished by a 3-in. pipe. The water passes first a balanced valve (A), Fig. 1, around which there is a by-pass controlled by valve (B). From the tee (C) the pipe is branched for the several brakes, 2½-in. piping serving for two brakes, and 2-in. for each individual brake. Valves (D) are provided in the supply pipe for each brake, so that any one may be entirely cut out or have its action modified to any desired extent. The water from each brake is returned by a separate pipe to a point (E), where valves are provided by which the amount of water allowed to pass each brake is regulated. The water flows from these valves in an open stream and is finally discharged into the sewer. The water pressure within each brake is indicated by one of the four gages at (F) Fig. 1.

The balanced valve (A) has its spindle connected with one of the levers of the dynamometer in such a way that its position is controlled by the pull, or, if backing, by the push exerted by the locomotive. Thus, suppose the locomotive is in motion and the outlet valves at (E) adjusted to allow the passage of water enough to keep down the temperature of the brakes, and suppose the pull of the locomotive is such as will bring the weighted lever of the dynamometer to its mid-position, then there will be a definite opening of the balanced valve, and a definite water pressure within the brakes will result. If, now, for any reason the weighted lever falls, there will be a corresponding increase in the opening of the balanced valve, and, hence, an increase of water pressure within the brakes. The greater pressure will result in greater resistance to the moving of the supporting wheels, and, hence, in a stronger pull of the locomotive on the dynamometer, and this increased pull will tend to lift the weighted lever again. Similarly, if for any reason the pull of the locomotive is sufficient to raise the lever beyond its central position, the balanced valve will respond by reducing the water pressure within the brakes; the tractive force of the engine will decrease and the dynamometer lever will fall. When, therefore, it is desired to increase the load on the locomotive, it is necessary only to place the additional weight upon the

* By apparent coefficient of friction is meant that factor which is obtained by assuming that the entire moment of the brake is due to the friction between the rubbing surfaces of the moving disk and the copper plates. Since there are other rubbing surfaces it is clear that the apparent coefficient of friction is larger than the actual coefficient.

lever of the dynamometer, and the corresponding increase in the load is furnished automatically by the brakes. By proper adjustment of the by-pass valve (B) the lever may be made to stand exactly in its central position.

The traction dynamometer is made up of a system of levers. The first lever in the system, shown by dotted outline at (G) in Figs. 1 and 2, has a direct connection with the locomotive drawbar. The last lever, shown at (H), carries an ordinary weight holder. The whole arrangement is such that, whether, the engine moves ahead or backward, the stress is transmitted by the drawbar and its value is shown by the weight necessary to balance the lever (H).



Arrangement of Levers.

A small dash-pot (not shown) is attached to the last lever, (D). The lever (C) has depending from it a light rod, which controls the balanced valve (B) Figs. 1 and 2 in the pipe supplying the brakes with water. By means of this valve, as previously described, the load on the brakes is made to vary automatically with the position of the last lever of the dynamometer.

The locomotive while in motion may be given a final adjustment to its place on the supporting wheels by means of the nuts on the drawbar. There is ample provision of chains and buffers to check any excessive movement of the locomotive.

A Sturtevant 4½ × 6¾ in. steam blower located above the stack (Fig. 1), but not in pipe connection with it, removes from the room every thing that is given out of the locomotive stack, without changing materially the draft conditions under which the locomotive is worked.

The boiler has a pipe connection with the stationary boiler which supplies steam for the general purposes of the laboratory, so that the locomotive may be used to supply steam to other apparatus, or the fixed boiler may be used to supply the locomotive. In the latter case the locomotive boiler is drained by means of the steam trap (M), which, by keeping the boiler free from water, allows all its parts to be at the same temperature.

Apparatus is conveniently arranged for measuring the fuel and water supply to the engine, the speed and slip of the drivers, and the discharge from injector overflow, cylinder cocks, etc.

Prof. Goss closes his paper with the following surprising error concerning the manner of testing the locomotive to represent its work on grades:

The matter of subjecting the locomotive to conditions similar to those of an inclined track has not been considered as in any way essential to the present scheme, and no complications have been added to the mounting mechanism with this end in view. It would appear, however, if the point of contact between each driver and its supporting wheel be such as to make their common tangents represent the desired grade, that then the conditions of gradient would be met. The nuts on the drawbar readily allow such an adjustment.

It is to be hoped that this is not a fair sample of the way in which experimental work with this locomotive will be carried out, for if it is we may expect to hear announced to the world from the Purdue laboratory that coal consumption is no greater on grades than on a level, or any other like revolutionary statement. It will be remembered that at the last meeting of the Mechanical Engineers the Publication Committee was severely criticised in one discussion for accepting a paper of doubtful value, which, however, was at least a record of actual facts. Just how the committee let this paragraph go into print uncorrected we do not understand. The small grain of truth which it contains does not all compensate for its misleading nature.

THE USE OF PETROLEUM IN PRIME MOVERS.

Prof. W. Robinson, M. E., in a recent lecture, took up the application of petroleum as a fuel for steam boilers. The following abstract appears in "Engineering:"

The first appliance for using oil in this manner described was Mr. Holden's injector as used on the Great Eastern Ry. In this device oil and air are drawn in by the action of superheated steam as in an ordinary injector, but lest the jet on issuing should be of the blow-pipe type and so injure the interior of the firebox, it is further broken up into a lambent flame by an auxiliary supply of steam issuing from a ring jet surrounding the orifice of the injector. The firebox is fitted with a firebrick bridge toward which the jet is directed, and the bars of the grate are covered with a thin layer of coal and chalk, the former of which burns slowly away. These engines can be run with coal without requiring any alteration to the furnace, a point of great importance in countries where the price of oil is fluctuating. The oil used by Mr. Holden is a mixture of two parts of coal tar with one of green oil, the cost being about 3 cts. a gallon. This injector has been modified by fittings, so that it may obtain its air supply from the train pipe of a vacuum brake, and in this way the vacuum is produced and maintained, without any extra

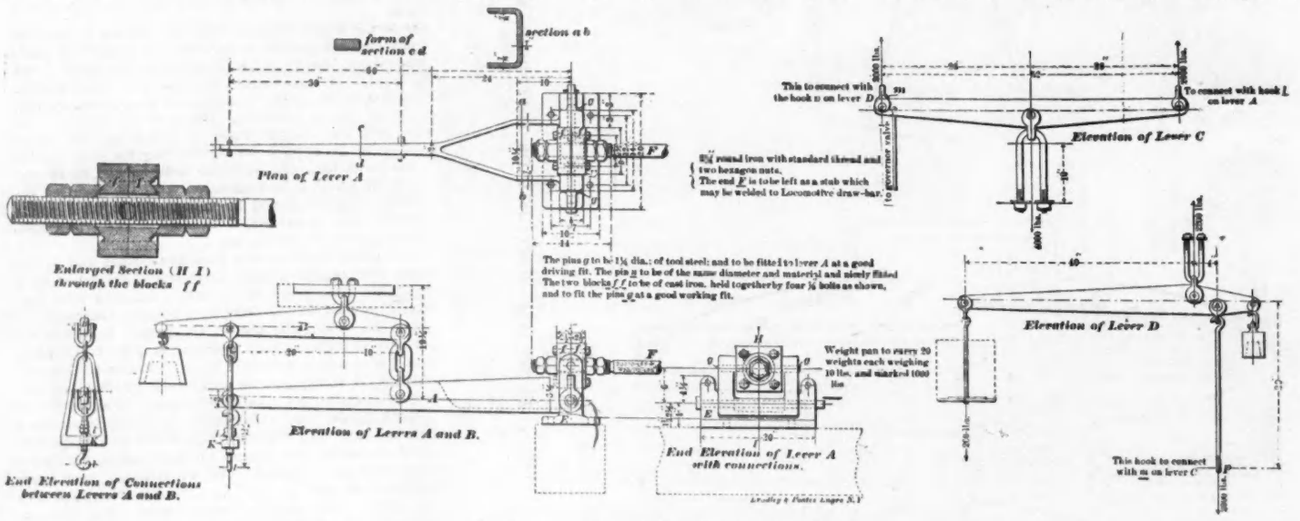

Plan of Lever A
Enlarged Section (H I) through the blocks f f
End Elevation of Connections between Levers A and B.
Elevation of Levers A and B.
End Elevation of Lever A with connections.
Elevation of Lever C
Elevation of Lever D
Weight pan to carry 20 weights each weighing 10 lbs. and marked 1000 lbs
This hook to connect with m on lever C

Fig. 4. LOCOMOTIVE DYNAMOMETER.

The details of the dynamometer are shown by Fig. 4. The main lever (A) is supported by a round steel pin which connects it with the cast plate (E), and which in turn is securely bolted to heavy timbers, forming a part of the framework behind the locomotive. The round rod (F) is an extension of the locomotive drawbar, and the pull ,or push, of the locomotive is exerted along the line of its axis. Stress is transmitted from this rod to the blocks (f) by nuts as shown; the fit between the nuts and the blocks being spherical (Fig. 4) to allow slight changes in the direction of (F). The blocks (f) are connected with the short arm of the lever (A) by the round steel pins (g), and the long arm of this lever is engaged by the hook (l), which is free to move within the link (k). To illustrate the action of this part of the dynamometer let it now be assumed that the pull of the locomotive on the drawbar (F) is ahead, that is in the direction of the upper arrow; then the stress on the drawbar will result in a tendency to raise the hook (l), and the lever (B) with its weight will serve only as a counterbalance to the lever (A). But, if it be assumed that the locomotive is working aback, that is, that the stress in the drawbar is in the direction of the lower arrow, the long arm of the lever (A) with the hook (l) will tend to fall. Motion of (l) in this direction, however, is soon arrested by the link (k), which by virtue of its connection with the lever (B) rises as (l) falls, until it engages the check nuts (i); these are thus made a means of transmitting the stress to the hook (l), which as before will move upward, while the shackle at the upper end of the hook (l) is entirely free from stress. It will thus be seen that whether the locomotive is working in forward or in backward gear, its tractive force is made manifest by an upward movement of the hook (l), from which point two simple levers complete the dynamometer. The amount of lost motion between the check nuts (i) and link (k) is very small.

The direction of the lever (C), which connects with hook (l), is at right angles with that of the lever (A), its purpose being to bring the last lever (D) of the system out from behind the locomotive. The lever (D) carries a weight holder arranged to receive twenty 10-lb. weights. The ratio of the whole system is as 1 to 100; each weight, therefore, that is balanced at the weight holder represents a tractive force exerted by the locomotive of 1,000 lbs.

expenditure of steam. In marine practice the injector has been fitted to draw in heated air, thus economizing fuel. Many modifications of these injectors had been proposed, such as Thwaite's, in which the spray did not pass directly into the firebox, but first into a red-hot drum in which the oil was converted into oil gas before being burnt. The most complete system of employing oil as fuel had been worked out in Russia by Mr. Urquhart. In this locality coal is dear, and petroleum residuum or astatki is very cheap. Nine years' experience of the system here has shown a notable economy to result from using the heavy petroleum refuse as fuel.

Exaggeration as to the calorific power of oil fuel was to be guarded against. By means of Favre and Silbermann's results, and those of Dr. Andrews, an approximate calculation of the calorific power of a fuel, the chemical composition of which was known, could be made in a way that was well known. But these values were not determined under the conditions which obtain in practice, and several necessary corrections were pointed out before the effective calorific value could be arrived at. As regards the use of creosote and blast furnace oil as fuel, Dr. Sadler, at Middlesbrough, had made a number of careful experiments, which showed that in the same boiler working under the same conditions, 1 lb. of creosote would give an effective evaporation at 50 lbs. per square inch pressure of about 12.5 lbs. of water, while 1 lb. of Durham steam coal evaporated 8 lbs., the feed water being supplied at 212° F. in both cases. But in addition to its greater evaporative power liquid fuel had many other advantages in

the ease with which the fires could be controlled, so that the output of steam could be readily proportioned to the work to be done, and taking this into account, Dr. Sadler concluded that in practice 1 ton of oil was equivalent to two tons of coal in evaporative power.

In spite of this superior evaporative efficiency, oil fuel was not necessarily more economical from a commercial point of view, as in most countries coal was considerably cheaper than oil, but where oil refuse could be obtained cheaply there was no doubt of its superiority. Thus Mr. Urquhart found that on his railway line a particular class of engine burned 79.08 lbs. of coal per mile, while similar engines fitted for oil burning used only 40.47 lbs. of astatki, and in special trials on large engines 45 tons of astatki were equal to 100 tons of anthracite. On the Great Eastern Ry. Mr. Holden finds that using oil, the consumption per engine mile averages 12.2 lbs. of oil and 11 lbs. of coal, or a total of 23.2 lbs. of fuel per mile. Burning coal alone, however, similar engines use 34 lbs. of coal per mile. On the Argentine Great Western Ry., engines using 33 lbs. of fuel per mile, when burning coal, use only 22 lbs. of oil. On the Tralee & Dingle Ry., where the coal consumption was 54 lbs. per engine mile (the grades being very heavy), only 8 lbs. of coal and 18 lbs. of blast furnace oil, or a total of 26 lbs. of fuel, are burnt when using Mr. Holden's apparatus, and a decided economy effected. On the Argentine Ry., where coal is very dear, about $20 a ton, the saving by the use of petroleum fuel amounts to $2,245 per engine per annum. In the case of steamships oil had additional advantages. In the first place, having a great calorific intensity, less of it was required, and a saving of cargo space would be effected. Moreover, coaling at sea, which was now a difficult operation, and which could only be accomplished in fine weather, could be done away with, as oil could always be easily transferred from one vessel to another by means of a suitable hose. On the other hand, the oil tanks when emptied of oil were liable to contain a dangerous gas which might cause serious explosions unless proper precautions were taken by using proper oil storage tanks and a suitable form of safety lamp to detect the presence of an inflammable mixture, naked lights being strictly forbidden.

The last way in which petroleum was used in prime movers to which he would refer was for lubrication. The mineral oils suitable for this purpose were distilled off after the intermediate oils had been collected. These oils had great advantages over animal or vegetable oils in that they did not absorb oxygen from the air, and thus cause spontaneous combustion. Heavy mineral oils were specially valuable for bearings, spindle, and steam cylinder lubrication, because they retained their good properties when heated, and did not thicken and oxidize like fixed oils.

Several of the practical tests of lubricating oils were considered, and the viscosity meter of Mr. Boverton Redwood described, and the method of using it explained. Many machines have been devised for testing the value of oils for the purpose of lubrication, but they were all somewhat unsatisfactory, and after all the best test was experience.

In conclusion, he might point out that he has shown that all the petroleum oils could be advantageously employed in one way or another in prime movers.

ELECTRIC HEATERS.

By W. H. Merrill, Jr., and F. E. Cabot.

The recent incorporation of a large number of companies for the avowed purpose of making and selling electric heating apparatus, together with the opportunities which certain fields seem to offer for the introduction of devices for the transformation of electric energy to heat, bring quite prominently to the view of the investor and the public the question of the actual worth and exact limits of usefulness of such contrivances. In common with most things bearing the name "electric," these limits are likely to be greatly exaggerated by the popular fancy and perhaps, also, by the promoters of the enterprises. It is not to be supposed that the attention of the capitalist, who is attracted by the idea of replacing cumbersome heating apparatus in houses by a simple system of wires, switches and artistically hidden stoves, will be called to the fact that the transformation of power to electrical energy through heat in the steam boiler and back again to heat involves a loss of over 90 per cent. Nor is it to be doubted that the popular fancy, which delights in "electric" combs and corsets, will be tickled with the idea that the chill airs of winter might be changed to tropical zephyrs if Edison would turn his attention to electric heaters. It is nevertheless true that the field of the electric heater is and will be comparatively narrow, though it may be almost infinitely long. When there is daily evidence of the adoption of electrically heated tailor's "gooses" by the proprietors of the so-called sweating shops, it is reasonable to believe that electric heating can be used with decided economy. Wherever a comparatively small amount of heat is desired to be automatically and uniformly maintained, and started or stopped on the instant without waste, there is the province of the electric heater. Again, wherever conditions prevent the use of the oil or gas stove, or the alcohol lamp, it may find a place; and lastly, where preference is given to appearance and convenience rather than to economy there, too, it may come into play.

One needs to visit the factories of some of the electric heating companies to be convinced of the numberless appliances which appropriately enter under the first classification, and which only need the proximity of a central station for their successful introduction. Ranging, as they do, from sizable stoves through flat irons and coffee urns to invalid packs and elegantly fashioned chafing dishes, they seem to furnish a field for great development. Under the second heading come the numerous conditions under which a source of heat is needed, but where the use of fire is attended with danger or serious inconvenience. Under this head we can properly class the heaters which have already been extensively adopted for use in connection with electric railway cars. The applications under the last head will be necessarily limited, including only such large apparatus as is brought into use to gratify individual fancy with little regard to its real merit.

The general design of these transformers of electrical energy into heat is based primarily upon Joule's discovery that the amount of heat developed in an electrical conductor is proportional to its resistance, to the square of the current strength, and to the time which the current lasts. The elementary form of heater, therefore, is some form of resistance, such as coils of thin wire or any substance of small electrical conductivity, introduced into an electric circuit and surrounded with a substance which will permit the conduction and radiation of heat, and at the same time serve to electrically insulate the resistance.

This resistance should be proportional to the electro-motive force of the current used and to the equation of Joule's law:

$$H = C^2Rt \times 0.24$$

where C is the current in amperes; R, the resistance in ohms; t, the time in seconds, and h, the heat in gram-centigrade units (the amount of heat which will raise one gram of water through 1 degree centigrade of temperature). Of course the increase of temperature in a resisting wire depends upon the nature of the resistance. A short length of thin wire, or of wire of poor conductivity may resist just as much as a long length of stout wire or wire of good conductivity. As shown by the above equation, the number of heat units evolved will be the same in either case, though in the former they will be concentrated, and in the latter dispersed throughout the length of the conductor.

Since the resistance of metals increases as their temperature increases, a thin wire heated by current passing through it will resist more, and grow hotter and hotter until its rate of loss of heat by conduction and radiation equals the rate at which heat is supplied by the current. Obviously, in a short wire, before heat enough can be dispelled for commercial purposes, fusion will begin; and in electric heaters it is necessary to use either long lengths of thin wire, or carbon, which alone of all conductors resists fusion. In the majority of heaters, coils of thin wire are used, separately embedded in some substance of poor electrical but good thermal conductivity, although patents are held on electric heating appliances using a carbon resistance.

Several modifications of these forms have been introduced with varying results. The employment of resistances made of metals of varying specific conductivity, seems advisable where varying conditions are to be provided for; but the use of independent devices for passing the current successively through the different resistances cannot add to the efficiency of the heater, though it may reduce its first cost. Again, the employment of any substance other than an excellent conductor of heat for the purpose of electrically insulating the resistance employed does not seem advisable, though some heaters are thus made. A greater temperature can of course be maintained without detriment in coils protected from the action of the air; and for this reason, as well as for mechanical strength, the coils of finished heaters are rarely exposed. Heat being the lowest form of energy, and the province of these devices being the conversion of a higher form of energy into heat, minute attention to detail in their construction is not essential. Generally speaking, any correctly proportioned resistance coil introduced into an electric circuit will work as economically as the latest patented form of stove. The question is not the economical transformation of electrical energy into heat, it is the converse, or practically: How much does the current cost?

Heat is supplied to boilers for generating steam, which in turn furnishes an engine with power to drive a dynamo-electric machine, which supplies current to the stove. In each one of these transformations energy is dissipated; in some of them a considerable amount. The economical question then is: Can one afford to purchase current for transformation into heat, taking into account the fact that he will be obliged to pay for these losses by dissipation, together with a margin of profit? It is hardly possible to give numerical values to the dissipation losses to fit the general case because of the wide difference in these losses under different conditions.

(As a general guide it may be said that the efficiency of an electric heating system taking current from a steam driven dynamo will be below 10 per cent., generally far below it.—Ed.)

In places where water power is used for driving generators instead of steam engines, a part of the loss through steam is saved, and in different systems of apparatus these losses greatly vary. The result of experiment is good practical proof, and as stated in the foregoing paragraphs such results show that conditions exist where heat generated by direct combustion is uneconomical in comparison with this circuitous method. That there must be "conditions" is evident, but well inside the restrictions these conditions impose, is found a fertile field whose boundaries are yet undetermined. Its first fruit of hardy growth is the tailor's "goose," in the hands of the Jew "sweater," whose proverbial passion stands as evidence to the world on this important question of economy. Certainly his ignorance of things electrical would never dim his insight into matters of profit and loss.

AQUEDUCT FOR THE WATER SUPPLY OF BOMBAY, INDIA.

The new water supply of Bombay, India (Eng. News, May 23, 1891, and April 9, 1892), is carried from the great Tansa reservoir partly by 48-in. pipe lines and partly by a masonry conduit. The works are described in part in a recent number of "Indian Engineering." The bridge which carries the 48-in. pipe over Bassein Creek consists of 15 spans, 100 ft. c. to c., with a grade of 2½ per cent. from each end to the center span, which is horizontal. This span gives a clear headway of 22 ft. over high water spring tides. Each abutment and pier consists of a pair of cast-iron cylinders 5 ft. diameter up to low water spring tides. At this level they reduce to 4 ft. diameter by a taper piece. Each cylinder is sunk to rock level and some of them are 75 ft. below the surface. They are filled with lime concrete, and each pair of cylinders is braced together from low water spring tides, upward by wrought iron horizontal and diagonal bracing. The superstructure consists of wrought iron lattice girders, 18 ft. apart c. to c. The girders are 9½ ft. deep. The lower chords carry cross girders of rolled beams laid 9½ ft. apart. The bridge is designed to carry two lines of 48-in. pipes, one on each side close to the main girders, and a line of tramway 2½ ft. gage in the center. Only one line of pipes is at present laid. Two smaller bridges, each of four spans and of similar construction, carry the pipe line over two smaller channels of Bassein Creek.

The masonry aqueduct which carries the masonry conduit along the ridge to the east of the Vehar Lake, 41 miles from the outlet works at Tansa, consists of 15 spans of 20 ft., with three arches of 10 ft. span at the north end and six arches of 10 ft. span at the south end. The greatest height from ground level to springing of arch is 20 ft. The aqueduct carries the masonry conduit, which is 7 ft.

wide between the side walls and 6 ft. high to springing of arch. The arch has a rise of 15 ins. and is 8 ins. thick. There are numerous aqueducts of this type on the line.

DECLINE OF POPULATION IN FRANCE.

The population of France is shown by official statistics for 1890 to be declining, the deaths continuing to outnumber the births. The loss of population by emigration is said to be small, the number of emigrants per annum being less than 34,000, while it is estimated that 64% of these return within 10 years to remain permanently. The two principal causes for the diminution of population are said by Mr. F. B. Loomis, U. S. Agent at St. Etienne, to be the harshness of the marriage laws and the maintaining of a standing army of over 500,000 men. The marriage laws throw many obstacles in the way of persons inclined to matrimony. Army life prevents men from marrying, and the enforced military service makes it impossible for many others to marry until late in life, as after leaving the army they have to find positions or careers which will enable them to support families. It is said that the statistics for 1890 show a greater proportion of deaths than in the year of the war, 1870-71, or in the cholera year of 1855, and this is partly attributed to the influenza epidemic. The number of marriages was only 7 per 1,000, the lowest rate for 40 years. The lightest death-rate was in central France, while the population increased more in the Southwest than in other quarters. The following is a tabular summary of the statistics for 1889 and 1890:

	1889	1890	Inc. or dec.
Births	880,579	838,059	− 42,520
Deaths	794,933	876,505	+ 81,572
Marriages	272,934	269,332	− 3,602
Divorces	4,786	5,457	+ 671
Illeg. births	73,521	71,036	− 2,485

An automatic car weighing machine is in use at the Wisconsin Central Ry. ore docks at Ashland, Wis. The train does not stop, but runs slowly, and the weight of each car is automatically recorded as it passes the weighing platform. The number and dead weight of each car are painted on the side, and are noted, so that the weight of ore can be easily ascertained.

PERSONALS.

Mr. D. H. Poynor has been elected City Engineer of Dallas, Tex.

Mr. Peter Sears has been elected County Engineer of Passaic Co., N. J.

Mr. A. G. Beckwith has been appointed City Engineer of Fredericton, N. B.

Mr. Jacob Stell has been appointed City Surveyor and Engineer of Rahway, N. J.

Mr. Wm. Hazelton has been appointed Assistant General Manager of the Short Electric Ry. Co., Cleveland, O.

Mr. S. A. Mitchell has been appointed Assistant City Engineer of Kansas City, Mo., vice Mr. A. M. Stalnaker, resigned.

Mr. Gustav Lindenthal sailed for Europe by the steamer "Elbe," North-German Lloyd, to be gone about six weeks on business for the North River Bridge Co.

Maj. J. F. Sessions has been re-elected President of the Mississippi Railroad Commission, and Mr. S. L. McLaurin has been elected Secretary, vice Mr. F. S. Schruggs, resigned.

Mr. Epes Randolph has been appointed Chief Engineer of the Western Division of the Newport News & Mississipi Valley R. R., vice Mr. A. T. Sabin, appointed Engineer of Bridges.

Mr. Thomas Aldcorn has resigned his position as Division Master Mechanic of the West Shore R. R., to accept the position of Mechanical Superintendent of the Empire Car Coupler Co., with office in New York.

Mr. James Grondie, who built the "Royal William" steamboat which made a trip from Pictou, N. S., to England in 1833, died at Chicago May 8, at the age of 83. This was one of the first boats to cross the Atlantic by steam power alone.

Mr. C. Harris, civil engineer, died recently in Boston from injuries sustained in being thrown from a carriage. He was 56 years of age, and in 1885 was Division Superintendent on the Michigan Southern & Northern Indiana R. R.

Mr. J. W. Kendrick, Chief Engineer of the Northern Pacific R. R., has been appointed Chief Engineer of the Northern Pacific and Chicago & Northern Pacific Railways, the engineering departments having been combined. Mr. W. S. Jones, formerly Chief Engineer of the Chicago & Northern Pacific R. R., has been appointed Chief Engineer of the Chicago Union Transfer Co.

Mr. John Carroll, a well known Canadian railway contractor, died at his residence in Toronto on Thursday, May 12, at the age of 66. Among the works on which he was engaged were the Welland Canal, the Niagara Central Ry., also the Toronto, Grey & Bruce, Whitby & Port Perry, Grand Junction, Kingston & Pembroke, Ontario & Quebec and Canadian Pacific railways. During the past three years he has been engaged on irrigating canals in Utah.

Gen. Wm. G. Halpin, who died in Cincinnati on May 8, in the 69th year of his age, was born in Ireland, and educated at Dublin University. He adopted the profession of civil engineering, came to America in 1848, and settled in Cincinnati, which city was his home, and which profession was his life work, except in those eventful years of his life when he served in the Union army, and in a long term of imprisonment which he was sentenced to as an alleged Fenian.

Before the war he was elected City Engineer of Cincinnati, and many years afterward was Chief Engineer of the Board of Public Works. During the past few years he has practiced the profession on his own account.

General Halpin was a picturesque and well known figure in Cincinnati, and his career was a most eventful and exciting one. He entered the army as a private in the 15th Kentucky Regiment, and by successive promotions became Colonel, finally leaving the service with the rank of Brigadier General. He always took an active interest in the affairs of his native land, and while abroad in 1867 was arrested as a conspirator and thrown into Kilmainham jail. He was sentenced to 14 years' imprisonment. Being an American citizen, his release was strenuously urged, but not effected until 1871, after four years' confinement. The principal obstacle was his refusal to accept anything except an unconditional release without signing any agreement to stay out of England, or to refrain from interfering in Irish affairs. His wife died childless in 1856, and he never remarried.

NEW PUBLICATIONS.

REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF KENTUCKY for the year 1891. Pub. Doc., 8vo., pp. 274.

This report is taken up largely with the discussion of rate and traffic matters and other questions regarding the legislative regulation of railways. It is gratifying to note that these discussions show a spirit of fair-mindedness and general knowledge of the subjects and are usually free from damagogism. There is very little of technical interest which we have not already published.

OHIO MINING JOURNAL.—Proceedings of the Ohio Institute of Mining Engineers for the year 1891. Columbus, O. 8vo., pp. 105; 25 cts.

In addition to reports, minutes of proceedings, etc., this number contains the following papers, with discussions: "Municipal Corporations and Natural Gas Supply," Prof. Orton; "The Ores of Virginia," J. A. Ede; "Blast Furnace Tar and Ammonia," Prof. N. W. Lord; "The Coals of the Twelve-Pole Region of West Virginia," Andrew Roy; "Management of Men," Wm. Hibbs; "Fatal Explosions in the Mines of England and Wales during the Last Half Century," Capt. J. L. Morris; "Bituminous Mining, Boss Examination in Pennsylvania," M. Quinn; "Difference Between Mining Coal and Iron Ore," P. F. Schmidt.

WATER-WORKS REPORTS.—The following water-works reports have been received, the names mentioned in connection with each report being superintendents, unless otherwise stated. Matter of general interest contained in water-works reports is given in this journal from time to time under the heading, "Notes from Recent Water-Works Reports." Receipt of the following reports is acknowledged:

Concord, N. H., V. C. Hastings; Manchester, N. H.; C. K. Walker; Boston, Mass., Wm. Jackson, City Engineer; Holbrook and Randolph, Mass., E. J. Chadbourne; Holyoke, Mass., J. D. Hardy; Lowell, Mass., S. P. Griffin; Medford, Mass., R. M. Gow; New Bedford, Mass., R. C. P. Coggeshall; Newton, Mass., H. N. Hyde; Waltham, Mass., Larry Brown, Clerk; Woonsocket, R. I., B. I. Cook; Hartford, Conn., Ezra Clark, President; Little Falls, N. Y., S. E. Babcock; Troy, N. Y., Edward Dolan; Norfolk, Va., H. L. Smith; Richmond, Va., C. E. Bolling; Roanoke, Va., J. C. Rawn, Manager; New Orleans, La., L. H. Gardner; Covington, Ky., W. H. Glore; Cincinnati, O., W. P. Tharp; Madison, Wis., J. B. Heim; Minneapolis, Minn., J. H. McConnell.

REPORT OF THE RAPID TRANSIT COMMISSION TO THE MASSACHUSETTS LEGISLATURE. April 5, 1892. Geo. S. Rice, Chief Engineer. 8vo., pp. 296; 31 folding maps and plates.

This is, beyond doubt, one of the most elaborate and complete reports ever submitted on an engineering question. Whether or not the suggestions are really wise and deserving of adoption we cannot pretend to say, as it would require much local knowledge and study to form an intelligible opinion. They strike us, however, as unnecessarily radical and expensive for a city like Boston, where there really is no rapid transit problem in the sense attached to that term in New York, since the railway terminals are all within easy walking distance of the business center. The average walk of the commuter from the railway station to his place of business will certainly not exceed half a mile, so that he does not even need to take a street car. There is much street car congestion, however, and now that electric propulsion is becoming universal in Boston, the natural remedy for that difficulty would seem to be some street car subways just below the surface of the crowded streets. The topography favors their construction, and that, we suspect, will be one of the first steps taken toward rapid transit.

Nevertheless, the Commission supports its recommendations by many strong arguments, and it is refreshing to see any public project so carefully studied as this report shows the Boston transit problem to have been. The report proper occupies only 120 pages of the volume, or 128 pages including a reprint of the laws affecting the Commission. The remainder of the volume consists of reports giving an immense amount of practical information in regard to rapid transit throughout the world. Most of this has already been very fully abstracted in these columns, so that it will suffice to say now that the salient facts in regard to almost every form of city transit in any part of the world are here given, often in much detail. As a work of reference alone this volume must continue for a long time to come to have no little value.

TRADE PUBLICATIONS.

VALVES, LUBRICATORS, ETC.—Lunkenheimer Brass Mfg. Co., Cincinati, O. 1892. 8vo.; pp. 98.

This is an illustrated catalogue and price list of brass and iron goods and specialties for steam, water, gas, oil, etc., and includes various kinds of valves, cocks, steam whistles, gages, lubricators and oil cups.

DRAWING INSTRUMENTS. Catalogue of the Ball-Ball Co., Frankford, Philadelphia, Pa. Pp. 24; illustrated.

Instruments in this list worthy of special mention are a Napier pocket compass of aluminum, and the patented duplex drawing pen which enables the draftsman to make a light or a heavy or a tapering line at will without readjusting the pen.

MECHANICAL FILTERS.—New York Filter Co., New York; oblong, 8vo., pp. 85.

This pamphlet describes and illustrates in detail the filters heretofore made by the Hyatt Pure Water Co., United States Water Supply Co., National Water Purifying Co. and American Filter Co. These companies were recently consolidated as the New York Filter Co. Prices for various sized filters of the different types are given and many testimonials from individuals, manufacturing firms and water-works officials having the filters in use.

SOCIETY PROCEEDINGS.

CIVIL ENGINEERS' CLUB OF CLEVELAND.—At the regular meeting May 10, Mr. C. W. Hopkinson read a paper on "Whither Is Our Architecture Tending," and Mr. Searles gave an account of the proposed North River bridge at New York. C. S. Howe, Secy.

NEW ENGLAND RAILROAD CLUB.—At the meeting on May 11, the last one of the season, the club was entertained by Col. Frank H. Forbes, with some reminiscences of early days in railroading in New England. Afterward the subject of amendment to Rule 8, of the Interchange Rules, was discussed. It was the general opinion that if any change was made it should be merely to adopt a uniform labor charge for changing brasses and brakeshoes, or to do away with the labor charge altogether. The question was also brought up whether the replacing of a brass, made necessary by a hot journal, should be charged to the owner of the car. The opinion was expressed that it should not.

NATIONAL CONFERENCE OF STATE BOARDS OF HEALTH.—The annual meeting will be held in Lansing, Mich., June 6. Among the subjects to be discussed are the following: "The Relation of the Laboratory of Hygiene to the Work of the State Board of Health," discussion opened by Prof. Victor C. Vaughan, Ann Arbor, Mich.; the general subject of state, interstate and international action to prevent the sewage pollution of streams, introduced by Dr. Benjamin Lee, Philadelphia, and Dr. P. H. Bruce, Toronto, Ont. "The Public Health Work in Washington," by Dr. H. B. Baker, Lansing, Mich. Report of the Committee on the Pollution of Streams and the Formation of River Conservancy Commissions.

WISCONSIN POLYTECHNIC SOCIETY.—At the meeting on May 9, President Benzenberg in the chair, a paper on "Wheel Records," by Mr. J. N. Barr, was read by the President.

Wheel records belong to that class of records which have for their object greater efficiency and economy in a special department. To establish the useful features of a wheel record, it is necessary to lay down

certain qualities of a wheel which, if united, constitute an "ideal" wheel. The ideal wheel being arrived at, the following departures from the same are noted, with reference to chilled cast iron wheels: 1, lack of roundness; 2, variation in thickness of shell of white iron; 3, imperfections in the white iron; 4, lack of requisite strength. To obtain further information on the subject, it is necessary to state the manner in which wheels fail. Wheels fail or are condemned from the following reasons: 1, failure of the shell of chilled iron; 2, abrasion; 3, breaking or fracture; 4, application of brakes. The character of service is also of material importance on the mileage of a wheel; therefore, the record will have to give information on this point. A distinction is to be made between wheels under freight and passenger locomotives, freight, baggage, passenger and Pullman cars, etc. Accurate wheel records, based on the principles briefly outlined by the paper, magnifested their efficiency in a very short time and did a great deal toward increasing the mileage of wheels.

AMERICAN WATER-WORKS ASSOCIATION.—The twelfth annual meeting of the association opened Tuesday morning, May 17, at the Metropolitan Hotel, New York, with President J. M. Diven in the chair. The calling of the roll showed about 60 active and 15 associate members present. The following were elected members. Active, C. L. John, Mt. Carmel, Pa.; C. W. Calkins, Rockford, Ill.; A. A. Tucker, Memphis, Tenn.; Thomas Watkins, Johnsontown, Pa. Associate members, Toledo Water-Works, Toledo, O.; Ross Valve Co., Troy, N. Y.

The President in his address called attention to the rapid growth of water-works in numbers in the 12 years since the association was formed. He discountenanced attempts made by cities to force private companies to sell their works at too low a price. Of the more than 2,000 water-works in the United States, as shown by the last "Manual of American Water-Works," the records show that only about one-tenth are represented in the association.

Referring to water-works reports, the President urged that more matter be inserted which would be of value for reference.

The pollution of water supplies and its prevention was also spoken of by the President. Prevention of pollution was considered as better than filtration.

After the address invitations were received to visit the Ridgewood pumping station of the Brooklyn Water-Works and the Engineers' Club of New York.

Rooms were provided for the exhibits made by associate members, and some of the principal specialties were as follows: Union Meter Co., Worcester, Mass., water meters and damper regulators; Thomson Meter Co., Brooklyn, N. Y., water meters; National Meter Co., New York, water meters; Hersey Mfg. Co., South Boston, Mass., water meters; Fairbanks Co., New York, N. Y., valves and cocks with asbestos disks and packing, vulcabeston rope packing and gaskets, Pratt's steam trap and boiler feeder, and the Hancock inspirator for locomotives and stationary boilers; Fisher Governor Co., Marshalltown, Ia., steam pump governors and pressure reducing valves; Michigan Brass & Iron Works, Detroit, Mich., Galvin hydrants; Eddy Valve Co.; R. D. Wood & Co.; Ross Valve Co., Troy, N. Y., mobile wedge gate valve (described in another column); A. P. Smith, Newark, N. J., method of connecting with street mains without shutting off water; Thomas Watkins, Johnstown, Pa., pipe jointer; Brass & Iron Works Co., Fostoria, O., Abel gate valves and Payne's tapping machine; H. Mueller Mfg. Co., Decatur, Ill., dry pipe and water pipe tapping machine, screw and tool drivers, water and gas specialties; Walworth Mfg. Co., Boston, Mass., Hall tapping machine, die plates, pipe cutter, tools, cocks, etc.; Holly Mfg. Co., Lockport, N. Y., hydrants and drawings of triple-expansion pumping engines; H. R. Worthington Co., New York, N. Y., meters, pumps; National Tube Works Co., New York, N. Y., pipe joint.

Tuesday Afternoon.

At the opening of the session Mr. Jay Chatham, Iowa City, Ia., was elected an active member and Mr. W. H. Bristol, Hoboken, of the Bristol Recording Pressure Gage Co., an active member. The report of the Executive Committee showed, among other things, that during the year the committee voted a salary of $500 to the Secretary for his year's service. The report of the Secretary and Treasurer, Mr. J. H. Decker, stated that four members had died during the year, as follows: L. Halsey Williams, Edward Armstrong, Nicholas Kuhen and Charles Elliott. The net gain in membership during the year was 18. There are now 378 members, divided as follows: One honorary, 303 active and 74 associate. The financial statement of the association showed a present balance of $586, a gain of $180 during the year. The total receipts during the year were $1,006, most of which were from admission and annual dues.

July 1, 1891, Secretary Decker resigned from his office, but owing to some defects in the constitution his resignation could not be accepted. Mr. Decker has been officially connected with the association since its foundation, 12 years ago.

Mr. L. H. Gardner, of New Orleans, submitted a resolution, which was adopted, to the effect that members should restrict gratuitous answers to inquiries from other water-works officials to other members of the association.

A paper was next read by Mr. Samuel McElroy, C. E., on the "Brooklyn Water-Works." These works have been fully described in past numbers of this journal. Mr. McElroy emphasized the importance of city ownership of the drainage areas furnishing the supply.

Mr. W. G. Nichols next read a paper on the "New Water Supply for Atlanta, Ga." This paper will be reprinted in our next issue.

"Who Should Do the Plumbing Work," was the subject of a paper proposed by Mr. L. E. Gray and read by the Secretary. Mr. Gray was in favor of the plumbing work being done by the water-works authorities at the expense of the consumers. This was urged on the ground of economy for all concerned and for the sake of securing better work.

At this point the President announced the following committee on revision of the constitution: Messrs. J. H. Decker, Peter Milne and Wm. Ryle. Mr. Decker was excused from serving on the committee, and President J. M. Diven was substituted.

A paper by Mr. J. Nelson Tubbs, on the "Particulars in Which Municipal Officers Should Protect the Municipal Corporation in Granting Water-Works Franchises to Private Water Companies," was read by the Secretary. This paper is published in full elsewhere in this issue.

This paper was followed by a lively discussion. Mr. J. T. Sawyer objected to the suggestion that in buying private works municipalities should not pay for the franchise, and seemed to think that the paper took the ground that water companies are regarded as enemies to the public (especially when successful). Mr. Peter Milne did not so understand the paper, and urged that Mr. Tubbs was only trying to suggest a course that would prevent trouble between companies and municipalities. Mr. Milne said that it must be remembered that water-works are for the people.

President J. M. Diven also objected to the principle that the franchises should not be paid for. Mr. B. M. Espy thought that cities wished to buy works when the companies were successful. He did not see why that when a company had brought its works to a point where 10 or 20 per cent. dividends were being paid, the city should have a right to purchase them. He thought that when a company had "struggled and manipulated and managed" it should be protected. He objected to Mr. Tubb's paper.

There were other remarks much in the same tenor as most of the above, and like them, made by parties interested in private companies, the speakers appearing to labor under the misapprehension that the paper under discussion was aimed against water-works companies. Mr. C. B. Brush, however, urged that such discussions were necessary, and brought out some of the difficulties of the problem, like the attempt by a small city to regulate a company's rates by those of a large city, where the works were owned by the public.

Just before the close of the afternoon session invitations were presented from the American Society of Mechanical Engineers, and from the American Society of Civil Engineers, to visit their rooms; also from Mr. C. B. Brush, to visit the high service works and aerating plant of the Hackensack Water Co.

Tuesday Evening.

A reception was tendered the association at the Metropolitan Hotel. Music and refreshments added to the enjoyment of the meeting.

Wednesday Morning.

The following were elected members at the opening of the session: Active—W. P. Tharp, Cincinnati, O.; G. P. Orcutt, Orange, N. J.; Geo. W. Aldridge, Rochester, N. Y.; J. W. Schrotch, Rochester, N. Y.; Wm. E. Hawks, Bennington, Vt. Associate members—Water Commissioners, London, Ont.; Dayton Water-Works, Dayton, O.

The first paper of the morning was by Mr. W. B. Rider, on "Reservoir Dams." Mr. Rider stated that frost caused more leaks in dams than any other factor. Eels and freshets were also spoken of as causes of dam failures. Mr. Rider had never known of a case where eels had worked into a puddle embankment.

Experience in Connecticut had shown Mr. Rider that spillways should be 5 ft. deep and 10 ft. wide for each square mile of watershed.

In the construction of dams, Mr. Rider preferred day labor to the contract system, as giving better results and being just as cheap. The paper was accompanied by illustrations.

The next paper was contributed by Mr. J. T. Fanning, C. E., and was read by the Secretary. Its subject was "Distribution Mains and Fire Service." The paper set forth in detail many of the considerations to be taken into account in designing distribution systems, and presented much valuable data. The paper will be published in a later issue of this journal.

In discussing Mr. Fanning's paper, Mr. F. L. Fuller called attention to the importance of the suggestions that hydrants and branches should be of good size and near togethe. Mr. P. D. Warner stated that Reading, Pa., had suffered from small mains and was now putting large supply mains, running north and south, through the city, from which small mains run east and west.

Mr. Edward Mather gave some figures showing the average number of hydrants per mile of main in various states. The average for the United States is 6.78 fire hydrants per mile of main.

Mr. Nichols stated that at Cleveland mains are to be laid from the harbor up several streets, diminishing from 10 to 8 ins. in diameter. These mains will be supplied, in case of fires, from the boats, which will connect with the main nearest the fire. The hydrants will be without valves, being merely stopped at the outlets. The mains will drain back into the lake, being laid very near the surface.

Mr. P. H. Lineen thought the plan outlined above not feasible, as it would be difficult to connect the boat with the pipe, and would take a long time to get the air out of the pipe. Mr. W. B. Rider thought ice in the lake would prevent the operation of the plan in the winter. Mr. Samuel McElroy and Mr. H. F. Dunham thought the plan feasible, but Mr. Dunham said it might not work in winter.

The next paper was by Mr. B. Jones, and was entitled "The Kansas City Case." The paper outlined the history of the National Water-Works Co., which supplies Kansas City, Mo., and the steps which have been taken by Kansas City, Mo., to build a plant of its own. The paper stated that the city is breaking its contract with the company in its efforts to build works, and aimed to show that the city cannot build the works for the $2,000,000 which it has voted for this purpose. Discussion of the paper was postponed until the afternoon session.

The proceedings of the remainder of the convention will be presented next week.

COMING TECHNICAL MEETINGS.

MONTANA SOCIETY OF CIVIL ENGINEERS.
May 21 Secy., F. D. Jones, Helena.
ENGINEERS' CLUB OF PHILADELPHIA.
May 21, 1122 Girard St. Secy., J. C. Trautwine.
CENTRAL RAILWAY CLUB OF BUFFALO.
May 25 Secy., Jas. Macbeth.
WESTERN SOCIETY OF ENGINEERS.
June 1, Secy., J. W. Weston, 470 La Salle St., Chicago.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 1. Secy., F. Collingwood. 127 East 23d St., New York.
June 8, Annual Convention, Old Point Comfort, Va.
ENGINEERS' CLUB OF ST. LOUIS.
June 1, Secy., Arthur Thacher, Odd Fellows' Building.
ENGINEERS' CLUB OF CINCINNATI.
June 2, Secy., J. F. Wilson.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
June 2 Secy., T. G. Philfeldt, 118 Adams St.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
June 2, At Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.
NEW YORK RAILROAD CLUB.
June 2, At 12 W. 31st St. Secy., H. G. Prout, 73 Broadway.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
June 2, Secy., C. H. McLeod, Montreal, P. Q.
ENGINEERS' CLUB OF MINNEAPOLIS.
June 2, Public Library Bldg. Secy., F. W. Cappelen.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
June 3. Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
June 3, Secy., O. von Geldern, 319 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
June 4, Secy., P. Valentine, At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
June 4. Union Station, St. Paul.
WISCONSIN POLYTECHNIC SOCIETY.
June 6, Loan & Trust Bldg., Milwaukee. Secy., M. G. Shinke.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
June 6, Secy., C. L. Annan.
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 6, 7. Grand Pacific Hotel, Chicago. Secy., R. W. Pope New York.
NEW ENGLAND WATER-WORKS ASSOCIATION.
June 8, 9, 10, Holyoke, Mass. Secy., R. C. P. Coggeshall, New Bedford, Mass.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
June9, Secy., Edward Mead, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
June 9, Secy., O. H. Landreth, Nashville, Tenn.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
June 10, Union Station, St. Paul.
TECHNICAL SOCIETY OF NEW YORK.
June 11, 194 Third Ave, Secy., H. Schreiter.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
June 11, At Roanoke, Secy., J. E. Schick, Roanoke, Va.
ENGINEERS' CLUB OF KANSAS CITY.
June 13, Baird Building. Secy., Waterman Stone.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
June 14, Secy., Parker N. Black, Capitol Block.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
June 14, Secy., C. S. Howe, Case Library Building.
NORTHWESTERN SOCIETY OF ENGINEERS.
June 14, Occidental Block, Seattle, Secy., E. H. Warner.
DENVER SOCIETY OF CIVIL ENGINEERS.
June 14. Secy., Geo H. Angell, Jacobson Block.
BOSTON SOCIETY OF CIVIL ENGINEERS.
June 15, Secy., S. E. Tinkham, City Hall
MASTER CAR BUILDERS' ASSOCIATION.
June 15, Saratoga, N. Y. Secy., J. W. Cloud, Chicago, Ill.
AMERICAN RAILWAY MASTER MECHANICS' ASSOC'N.
June 20, Saratoga, N. Y. Secy., A. Sinclair, New York.
WESTERN RAILWAY CLUB.
June 21, Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
June 21, Secy., R. N. Lark, Pittsburg, Pa.
AMERICAN INSTITUTE OF MINING ENGINEERS.
June 21, Plattsburg, N. Y. Secy., R. W. Raymond, New York.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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VOL. XXVII. THURSDAY, MAY 19, 1892.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

We have lately published a good deal of matter showing how exceedingly grave is the situation of Chicago in respect to pollution of its water supply, and how important it is that just the right plan should be adopted for remedying the difficulty, and that no time should be lost in carrying it out when determined. As is well known, a great artificial river channel to carry 10,000 cu. ft. of water per second out of Lake Michigan into the Mississippi drainage basin is the accepted remedy; but it is still in dispute just how and where it should be dug. The work is in charge of a drainage board of seven men. Mr. Benezette Williams is engineer of the board, a well known engineer, and one never yet accused of unwillingness to assume proper responsibility when he felt clear in his own mind as to just what should be done. Mr. Williams has recently applied to the board, asking for the appointment of three consulting engineers to join him in examining and reporting upon certain features of the problem, the report to be made within two weeks after the opening of bids for construction, upon a specified list of questions. By a vote of 4 to 3 (5 to 2 being required in favor of any proposition involving the expenditure of money) the board refused this request, and instructed Mr. Williams to "go it alone"! Among the three dissenting votes was Commissioner L. E. Cooley, the only engineer on the board.

This last fact would seem to indicate that there may be circumstances about the application, justifying refusal, which are not clear to outsiders. There has been a terrible amount of politics and of wheels within wheels in the handling of the question from the first. But on the face of it, the refusal is an outrageous breach of reason and common sense. In all such cases, the more haste the less speed, unless it is determined by a large preponderance of evidence just what ought to be done before trying to do it. To refuse to the chief engineer of such a work the privilege of consulting with other engineers before assuming further responsibility seems an act of the greatest folly. It apparently means that the commissioners prefer to be their own consulting engineers and to intrust their chief engineer with power only to execute their decrees.

Two years ago, when the North River Bridge Co. obtained legislative powers from Congress, it was generally supposed that it would require legislation also from the states of New York and New Jersey to supplement the powers given it by Congress. We have pointed out several times that this supposition is erroneous; that the congressional act alone gave full powers of condemnation both in New York and New Jersey, and that precedents established that this was entirely constitutional. A recent decision of the U. S. Circuit Court for New Jersey fully supports this view. The company's bridge is located to cross nearly east from Hoboken to the foot of Twenty-second St. in New York, with the station at Twenty-eighth St. and Sixth Ave. As soon as the location was approved by the War Department, the bridge company commenced condemnation proceedings on the New Jersey side against certain property owners. The application of the bridge company was strongly opposed by them on the ground that its charter was unconstitutional and void, and that Congress could not confer the right of eminent domain upon the bridge company. But on April 19, Judge Acheson, of the U. S. Circuit Court for the District of New Jersey, in Trenton, decided that the North River Bridge Co. had clear rights of condemnation, and he appointed three commissioners to appraise the property wanted by the bridge company. The property owners, not being satisfied with the decision of the U. S. Circuit Court, will appeal to the United States Supreme Court; but there seems to us little room for doubt that the judgment of the Circuit Court will be sustained by the Supreme Court.

On the other hand, the so-called "New York & New Jersey Bridge Co.," which has a charter from New York and has secured control of an old New Jersey charter, is not in a very strong position even if it should get permissive legislation from Congress, which so far has been refused. It is claimed, at least, that under the present constitution and laws of the states of New York and New Jersey, the incorporation of a company for bridging the Hudson River for railway purposes is of doubtful legal validity, even if the charter powers from the states should be supplemented by legislation from Congress. Before the money for so vast a work can be raised by any company its legal powers must be established beyond all dispute, and the North River Bridge Co. is acting wisely in having its legal powers passed upon by the Supreme Court in the beginning, so that there may be no chance of obstructive litigation during construction to frighten away capital.

The War Department, to whom the Senate Committee on Commerce recently referred the bill of the New York & New Jersey Bridge Co. authorizing another bridge over the North River some miles above the Lindenthal project, has reported certain amendments for the protection of navigation. It insists upon a single span over the entire river between the established pier headlines in either state, and on a clear height of not less than 150 ft. above high water. The same conditions were insisted upon in the charter of the North River Bridge Co., and we think wisely in both cases. The day will come when the commerce on these rivers will be many times greater than it is to-day. During foggy weather in the fall and winter the danger from collision is already great, and would be still greater if bridge piers should be allowed in the river, with swift tidal currents changing their direction twice a day. We hardly expect to see the New York & New Jersey bill pass at all, in any form, however, at least at this session. After it has become clear that the charter already given to the North River Bridge Co. is not to result in construction within a reasonable time, it will then be time enough to charter another company. At present the only effect of two competing charters would be to seriously obstruct raising money under either. It is obvious that for the present there is not room for more than one bridge.

We publish elsewhere the preliminary report of the American Society of Mechanical Engineers appointed to formulate a standard method of conducting locomotive tests. The names appended to the report are alone sufficient to give it no small importance and interest. The committee compare the need for the standard they are called on to formulate with the need for the standard code for boiler tests and for duty trials of pumping engines which have already been adopted by the society. But boiler tests are almost invariably made to ascertain either the economy or the capacity of a boiler. In duty trials of pumping engines, one main fact only is to be ascertained. Locomotive tests, however, may be made to determine a score of different questions, and the method of conducting the tests will vary necessarily, according to the information desired. The committee have recognized this in their report; but perhaps not so fully and explicitly as would be desirable. Their report covers the use of indicators, methods of measuring fuel and water and of taking calorimeter and dynamometer records, and directions for boiler tests and coal tests. For determining the effect of changes in special details, such as a valve gear or valve setting, an exhaust nozzle, or a grate bar, the experimenter can choose such tests as are necessary. The general criticism which will probably be made on this report by master mechanics and railway officials is that it demands too much, and makes a test conforming to the standard in every respect rather difficult and expensive. For example, while it is undoubtedly desirable, as the committee says, that locomotive tests should be made with a special train, the expense and the difficulty of running special trains on a crowded road make the recommendation one of questionable wisdom. Considering the interruptions in the running of a special which has to keep out of the way of other trains, it seems likely that tests with a through passenger or freight train would be quite as satisfactory. Money spent in tests of this sort is sometimes appropriated grudgingly by higher officials, and in any case it is always desirable to get the most information at the least expense.

Again, in making boiler tests the committee recommends that an analysis of the smoke-box gases be made. There are few railways, however, which have the facilities for doing this, and while the interest and value of such analyses in many cases is undeniable, it is a question whether they would often be made, even if recommended in a standard code. To state the question in a general way, is it not desirable that a standard code of tests should contain only those tests on whose utility and necessity engineers are generally agreed, leaving tests of especial difficulty and those which are seldom required, to be added by experts whenever the importance of the trial makes their use advisable?

The question of English vs. American locomotives is being discussed in a somewhat novel manner in New South Wales. A Mr. Hoyle, member of the legislative assembly, and formerly a foreman in the Interlocking Department, from which he was dismissed for making political speeches against the Railway Commissioners in the railway workshops, has discovered that Baldwin engines are full of evil designs and bad workmanship, seeking to prey upon the innocent lambs who form the major portion of the inhabitants of New South Wales. Mr. Hoyle, being a legislator, has a hall already hired for his use at his country's expense, and in it he has proceeded lately to endeavor to show how much better he could make a locomotive than Burnham, Parry, Williams & Co. If we have grasped his argument aright, axles made by him would never run hot, even if they were not oiled, draw gear would never break, all tube sheets would be thicker than an armor plate, brass crosshead rubbing pieces would wear indefinitely, and peace and plenty would reign all the year round. Mr. Hoyle, instead of sticking to and defending his own positions, actually called the officers of the road as witnesses to prove his case, and these, strangely enough, testified on oath before a Royal Commission that the impeached engines hauled considerably greater loads than any previous engines, and that, while the iron used in the engine truck axles was bad, no one could have detected the defect beforehand without testing the axle to destruction, and that while the workmanship of the wrought iron driving wheels (Vauclain's patent) was far rougher than in English locomotive wheels, there was no defect in the wheels, nor had they failed in any way in working. The screw reversing gear had given some trouble. The engineer in charge of the track testified that the Baldwin ten-wheel passenger engines damaged the track less than the two four-wheel coupled English engines formerly employed to run the same trains over the mountain grades of 176 and 132 ft. per mile. As most of the witnesses were, as some of them stated, in favor of English practice, with which they were best acquainted, their testimony in favor of the

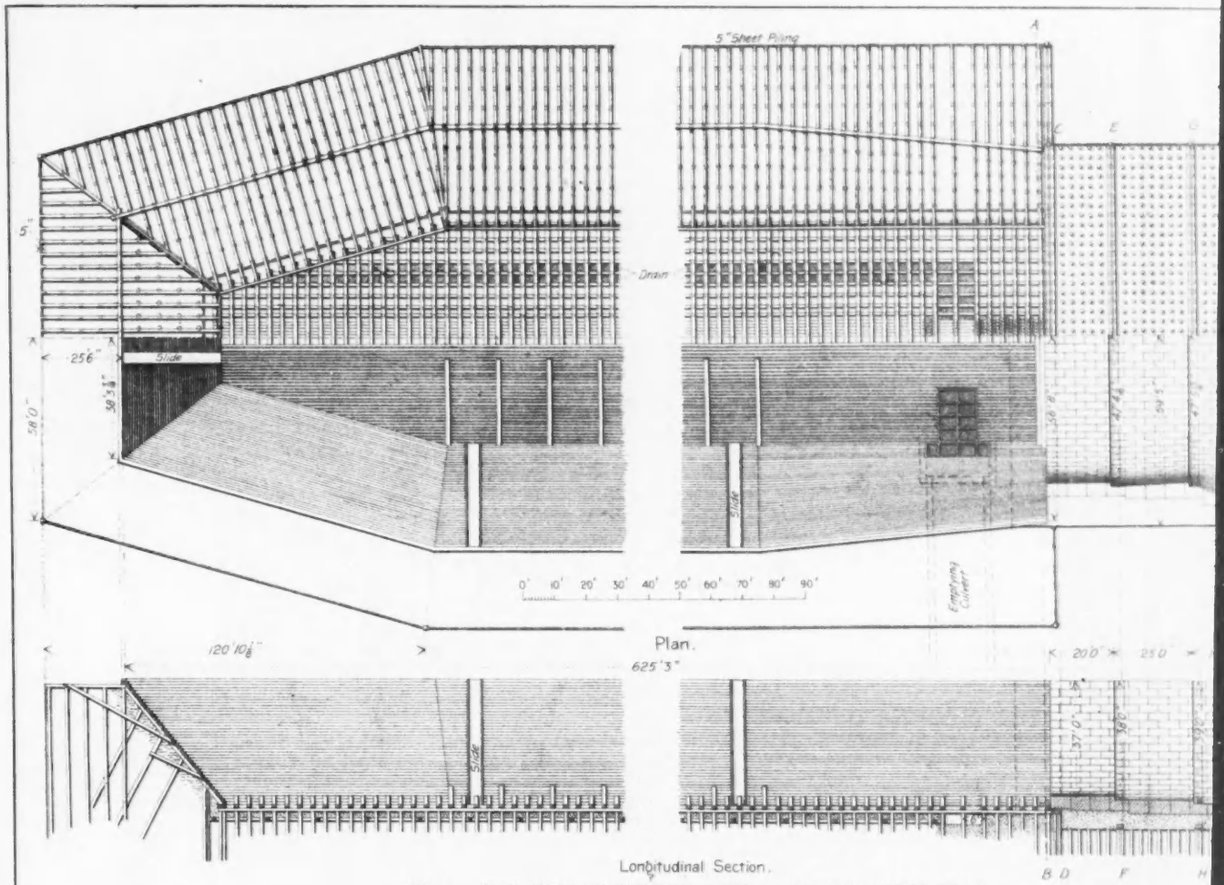


FIG. 4. PLAN AND LONGITUDINAL SECTION OF COMPLETED DOCK.

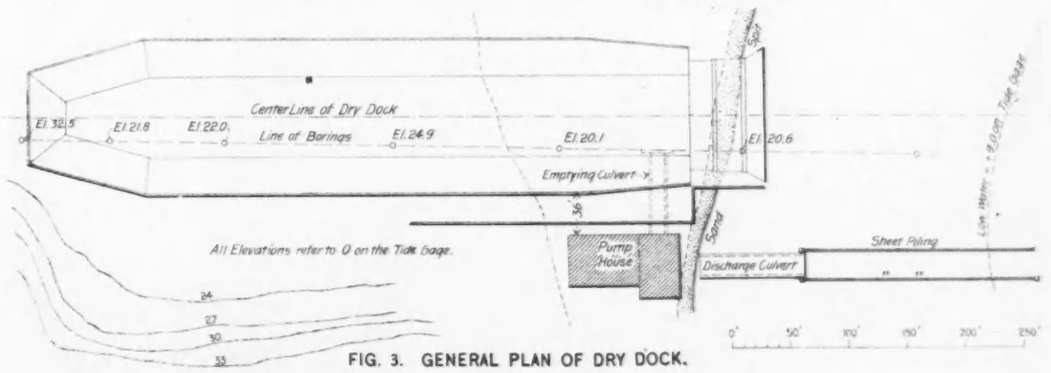


FIG. 3. GENERAL PLAN OF DRY DOCK.

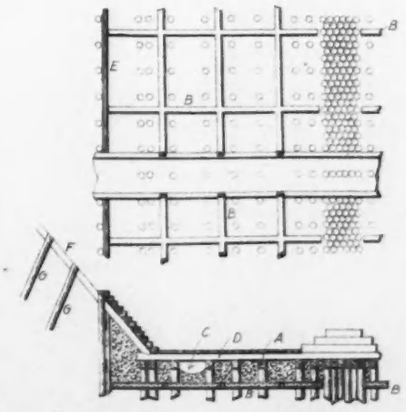


FIG 1. PLAN AND SECTION OF ENDICOTT'S PATENT DRY DOCK.

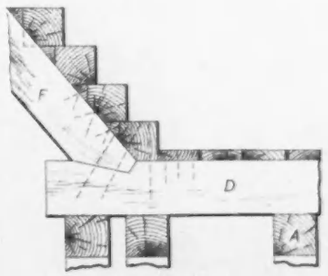
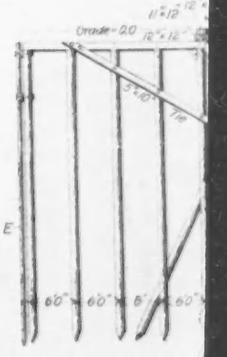


FIG 2. CONSTRUCTION OF ALTARS.



DRY DOCK FOR THE U. S. NAVAL STATION AT

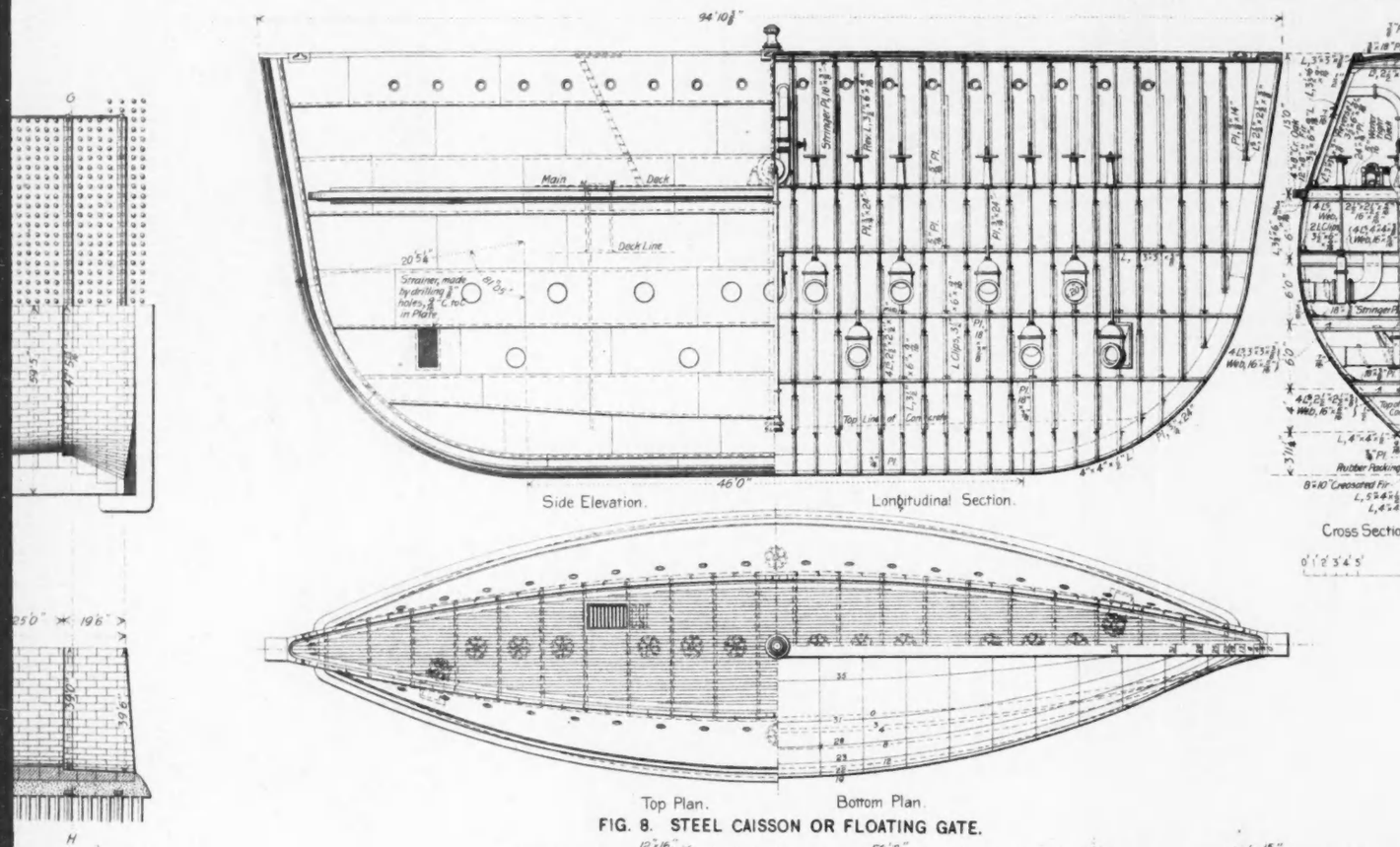


FIG. 8. STEEL CAISSON OR FLOATING GATE.

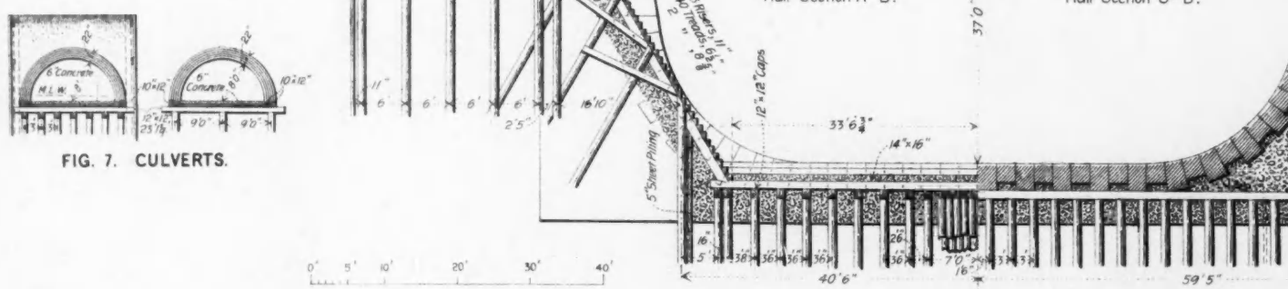


FIG. 7. CULVERTS.

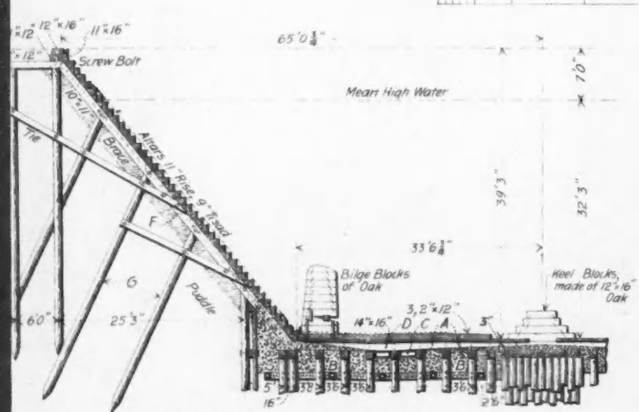


FIG. 5. CROSS SECTION OF BODY OF DOCK.

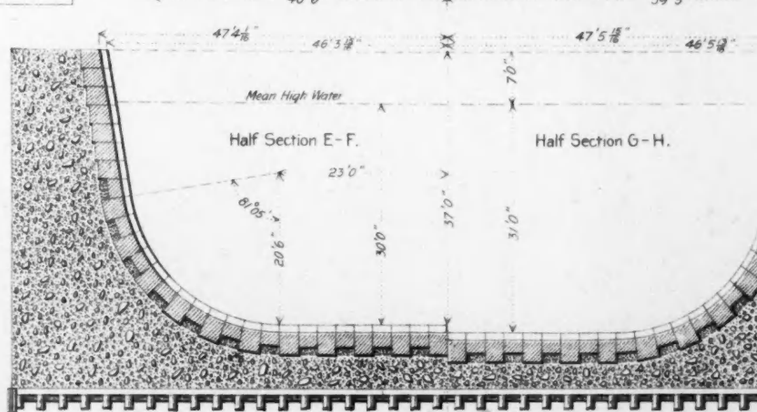
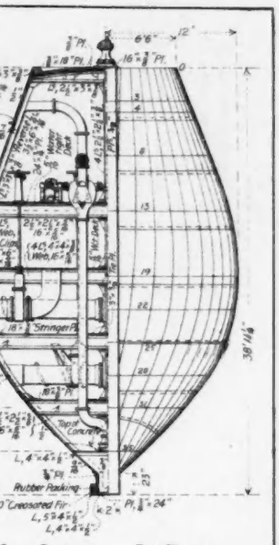
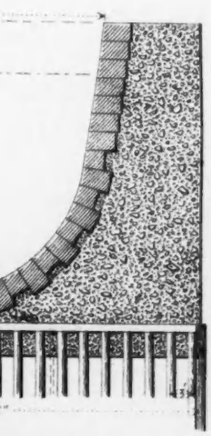
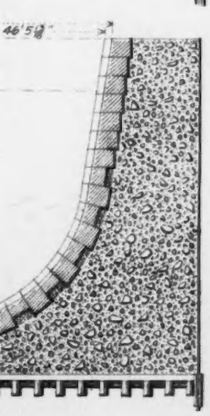


FIG. 6. CROSS SECTIONS AT DOCK ENTRANCE.

AT PUGET SOUND, WASHINGTON. Engineer, M. T. Endicott, Civil Engineer, U. S. N.







CHAS. HART & SONS, LITH., 35 VESEY ST., N. Y.

Hoyle-bespattered American locomotive is all the more gratifying; but should New South Wales finally "go back on it" altogether, there will still be more train miles made by them in the world than by all other kinds put together, and the American locomotive will survive the shock.

THE PROS AND CONS OF IRON CAR CONSTRUCTION.

It is an admitted and undeniable fact that few corporations, and still fewer managers of corporations, enjoy making large investments in the nature of additions to capital account to effect dubious future economies. The reluctance is natural, and proper enough within reasonable limits. It is but human that the manager who is largely judged by immediate results should often carry it to unreasonable limits, and thus neglect to keep up with the procession in matters like freight train brakes, automatic couplers, block signal plant, improved types of rolling stock and the like, even when it can be easily shown that the improvement will not only tend to greater safety, but be a direct source of profit.

That all the betterments named except the last are (or will be when in general use) direct sources of profit as well as of safety has been shown in various earlier issues of this journal. We propose now to show that the same is equally true of iron or steel freight cars, provided only it be true, as claimed, that for not over $100 extra cost a freight car of equal strength and 15% less weight can be obtained.

Quite apart from what is or is not realized in individual designs now on the market, these claims seem to us inherently reasonable. If they are not realized now, they can be and will be realized in time. In fact, the saving of weight for equal strength ought to be considerably more than 15%. The drawbar attachments can be made considerably lighter as well as stronger, and the same should certainly be true of the sills. The percentage against wooden brake beams and bolsters is much heavier yet. On the other hand, the present M. C. B. allowance for the difference between wooden and iron trucks is $50, which is rather more than the real difference, leaving over $50 to cover the cost of the difference in the car body. As the chief expense of the substitution lies in the sills and floor of the car, and the present standard cost of a gondola or flat-car body is only $125 to $150, $50 to $60 more, on an average, should be sufficient to cover the extra cost of substituting steel for all wooden parts for which it is suitable. The floor and interior siding, at least, if not the sides, doors and roof, will be likely to always remain wood.

In balancing the debit and credit side of this extra expense, we shall neglect wholly two or three items which are apt to be most considered, namely, the difference in cost of repairs, in rate of depreciation, in value of scrap, and in liability to break-in-twos and destruction in accident. It may or may not be that there will be considerable economies in these items. It seems reasonable to expect that there will be some economy in all of them, and a considerable economy in some of them; but the great item of economy should be the increase in the average live load of trains due to the decrease of 15% in dead load. This may be computed as follows:

The debit side of the account may be taken at $10 per car per year, or 10% interest on the extra investment. To show that there would be no loss a 6% interest might suffice; but few companies care to increase their permanent investment unless they can see where at least 10% profit yearly should be gained on the investment.

To determine the credit side, the average work done and money earned by a freight car yearly, as indicated by the last issue of Poor's "Manual," may be taken as follows:

	Total in U. S.	Per car.
No. of freight cars	1,061,970	.....
Freight earnings	$740,374,844	$696
Tons moved	701,344,437	659
Ton-miles	79,192,985,125	74,300
Freight train, miles	496,680,538	466

Some cars do four or five times as much work and earn four or five times as much money as the average indicated in the last column, but we will take the average car, which in round numbers handles about 75,000 ton-miles of freight, earning for it an average of a little less than a cent per ton-mile.

Of this ton-mileage at least two-thirds (on many roads much more) is earned for haul in the direction of heaviest traffic, where every train is supposed to be, and for the most part is, loaded up to the full working capacity of the engine. The average rate on this part of the traffic is on the whole about the same as on that hauled in the reverse direction, so that about two-thirds of a car's earnings also are earned in hauling with the burden of traffic. There is a much stronger tendency to give low rates for hauls against the burden of traffic, but on the other hand, in the United States at least, this reverse traffic is largely freight which can afford to pay a higher rate, so that the mean rate is about the same in both directions.

It is only to this two-thirds of the traffic that reduction of dead weight is of any measurable value. The cost of handling the remaining one-third is decreased only by a very slight saving in coal burned and in wear and tear, which may be of some little moment but is hardly computable.

Freight car weights and capacities have been changing so rapidly of late that it is hard to state any average values correctly, but in a general way it may be stated that in fully loaded trains the live load is about twice the dead load, and is still tending to increase relatively. A 50,000-lb. car will weigh a little less than 25,000 lbs., and may be taken as a type. A 60,000-lb. car will weigh considerably less than 30,000 lbs., and an 80,000-lb. car greatly less than 40,000 lbs., but even with these still exceptional cars the average live load of loaded trains as they run will rarely exceed twice the dead load of cars even in the direction of heaviest traffic.

Hence a reduction of 15% in the dead load means only 5% decrease in the total weight of the loaded car; but that 5% decrease means that there can be on an average 1-20 more cars in each train, or 1-20 less train-mileage per car for an equal yearly ton-mileage. We have seen that at the present time there is an average of 466 train miles yearly per freight car, 5% of which is 23.3 train miles per car; which is the train-mileage that can be saved by 15% reduction in dead weight.

At the average cost of $1 per train-mile this would amount to a saving of $23.30 per car per year, but this would be an overestimate. The cost of a little more or less train-mileage is very much less than the average cost. Careful estimates show it to be as nearly as may be an even half only of the average cost.* But even at this rate the yearly saving "in sight" is $11.65 per car, or 11.65% on the extra cost of the steel construction.

This is a minimum estimate. Let us suppose, for example, that by the substitution of steel for wood a 60,000-lb. car weighing 27,000 lbs. is not only decreased some 4,000 lbs. in weight, but so increased in strength that it can carry 4,000 lbs. more of load, thus leaving the total weight of car and load the same. The average load of that car, even in the direction of heaviest traffic, will not be over 50,000 lbs., and hence that increase of 4,000 lbs. in capacity means an increase of 8% instead of 5% in the average live load of trains, and increased earnings of $18.62 instead of $11.65 for the average freight car.

When we further remember that many classes of "line" cars and others do three to five times as much work as the average yearly, with corresponding increase in earning capacity from decrease in dead weight, the argument in favor of steel construction for such classes of cars (assuming always that it will accomplish what is claimed) becomes very strong, indicating a saving of $50 to $90 per car in the cost of operating, or 50% to 90% per annum on the extra investment. And this increase, moreover, is not subject to the severe condition of the like gain in hauling capacity from automatic brakes and couplers, that it is realizable only when the new type is in practically universal use. The gain from saving in dead weight is measurably realized from every car which goes into service.

Compared with this saving the utmost which can possibly be realized from the direct economy in repairs is relatively small, as becomes clearer when the distribution of expenses for car repairs and renewals is considered, for it is then seen that fully 75% of the present cost of car repairs will not be affected at all by the change from wooden to steel construction.* The items affected and not affected, and the percentage which they form of the total cost of repairs are as follows:

Wheels, (30 p. c.); axles, brasses and axle boxes (30 p. c.)	60 p. c.
Springs (10 p. c.); car floors and siding, painting, etc., (5 p. c.)	15 "
Total not affected	75 p. c.
Truck frames and fittings, 5 p. c.	
Brakes (5. p. c.) sills and attach'ts (5 p. c.)	10 "
Draw gear	10 "
Total affected	25 p. c.

The total cost of car repairs and renewals per year is rarely much less than $50 per car in fact, though continual additions of new stock often make it appear lower. Of this, $37.50 per year, about, is not affected in any way, and at the most not over half of the remaining $12.50 per year could be saved, leaving a possible $6.25 per car in sight as the direct saving in repairs, which may not be really more than $5. There should surely be something like that saving, however, and that alone means 5% per year on the assumed extra cost, leaving the much larger saving above computed as nearly net gain.

These facts lead us to believe that steel car construction has come to stay, and to rapidly increase. The next development may well be 12-wheel cars of about the size of baggage cars, and with much better springs under them, so as to be fit for occasional high speed, and with a capacity of perhaps 100,000 lbs. With such cars, all equipped with train brakes and close couplers, and handled down grades and on levels at any handy speed up to 40 miles per hour, freight rates may touch depths not dreamt of yet, and still leave a larger profit on each ton handled than is realized to-day.

* See "Economic Theory of Location of Railways," p. 571, where 49½% only of the average cost per train mile is found to vary directly with small changes in train mileage, the remaining 50½% being unaffected until the change becomes large.

THE SEWERAGE SYSTEMS OF THE NEW ENGLAND STATES.

We present elsewhere in this issue a tabulated description of most of the sewerage systems of the cities and towns of the New England states, 88 municipalities being included in the list. This will be followed by similar facts and figures for the remainder of the United States and for Canada.

This information has been secured by means of blank forms sent first to city engineers, and in case no report was secured from them, then to other city officials. The work of collecting the information was begun Oct. 1, 1890. Much difficulty was experienced in securing reports from some cities, so that months passed before an approach to complete returns was made. Press of work and the hope of yet securing reports from all cities having sewerage systems caused the postponement of the publication of the returns. As at least ten unsuccessful applications for information have been made to some cities known to have sewers, we have concluded to publish the returns already in, leaving the delinquent cities to be considered as without sewers, too negligent to report, or as ashamed of the poor systems, or lack of systems, in use. We shall be pleased to receive reports from these delinquents, and to publish them later if their numbers will warrant such action.

We are well aware that many city engineers are poorly paid, or paid only for work ordered by the city government, and that this accounts for the lack of records and the consequent unwillingness to attempt to make a report which cannot be complete. Many city engineers, or other city officials, have done much work in order to get up the reports requested, and we take pleasure in acknowledging the hearty responses made by a large number, and also in thanking all who have aided in bringing together what we believe will prove to be the largest and most valuable collection of sewerage statistics ever published.

The month and year in which each of the reports was made are given in the last column of the table. In a few cases the figures were for an earlier date than the filling in of the blanks sent, as indicated by foot notes.

The many blank spaces in the table are largely due to the lack of records, just named, or to the

* See for details "Economic Theory of Railway Location," pp. 161-8.

TABLE A.—SEWERAGE SYSTEMS OF THE NEW ENGLAND STATES.

	Pop., 1890, 1 = 1,000.	Year started.	System.	Discharge into	Area city, sq. m.	Streets, in miles, Tot.	Sewers, in miles, P'v'd.	Sewers, Small-est size.	Sewers, Length, est miles.	Sewers, No. con-nections.	Manholes, Total.	Manholes, Venti-lated.	Catch basins.	Lamp-holes.	Cost of sy-stem.	Cost per year, nearest report, for Repairs.	Cost per year, nearest report, for Cleani'g.	Sewers in charge of	Date report.
MAINE.																			
Auburn	11.3	....	Comb.	Androscoggin R.	3	45	3	8	..	700	150	...	400	..	$75,000	$50	$200	Com. Cy. C.	12-90
Bangor, F	19.1	1860	Comb.	Penobscot R. (a)	..	..	½	20	..	...	...	...	...	0	275,000(c)	....	....	S. Board.	10-90
Bar Harbor, F	...	1888	Sep.	Ocean	1	8	0	..	6	...	92	0	0	0	122,800	300	100	Selectmen	12-90
Belfast	4.5	1890	Sep.	Bay	.	14	0	3-5	8	...	5	5	...	6	5,000(c)	....	....	Com.	3-91
Booth Bay Harbor	1.7	1890	Comb.	Harbor	.	20	0	1-10	..	...	...	...	...	..	350	0	0	Selectmen	-91
Brewer	4.2	....	Comb.	Penobscot R.	.	..	0	4	12	...	...	...	...	..	.....	....	....	Com.	10-90
Gardiner	5.5	....	....	Kenn. & C. C. R's.	.	..	..	½	..	few	...	...	...	..	.....	....	....	.....	12-90
Houlton (Co.), F. (d)	4.	1888	Sep.	Stream (e)	.	5	0	1½	6	30	14	14	0	6	.....	....	100	.....	12-90
Lewiston	21.7	....	Comb.	Androscoggin	4	30	8	15	..	2,000	...	...	...	..	200,000	...	....	St. Coms.	2-91
Old Orchard, F	.9	1884	Sep.	Ocean (e)	3	8	0	2½	6	300	45	0	8	0	.....	75	10	.....	1-91
Portland, F	36.4	1857(f)	Comb.	Ocean (g)	2½	56	9	38	10	(h)	169	80	711	0	(i)	1,828	2,074	Com. Ald.	1-91
Presque Isle	3.	1888	Sep.	Presque I. R.	2	2½	..	..	⅛ 8	50	0	0	0	0	1,500	0	0	.....	12-90
Waterville, F	7.1	1888	Comb.	Kennebec R.	14	80	0	7	8	70	110	0	146	34	60,000	0	150	S. Com.	10-90
York Beach (j) F	...	1889	Sep.	Ocean	..	..	..	3-5	6	9	6	4	...	..	2,100	0	3½	.....	3-91

F. Flushing Devices.—Bangor, Bar Harbor, Old Orchard (continuously), Portland and Waterville flush from hydrants; York Beach from a brook; Houlton has three Van Vranken flush tanks, discharging 280 gallons every six hours; Presque Isle reports three devices, kind not given; six towns do not report.

NEW HAMPSHIRE.																			
Concord	17.	....	Comb.	Merrimac R.	8	147	9	40	10	2,003	251	...	252	130	.....	....	....	Cy. Gov't.	3-91
Keene, F	7.4	1883	Sep.	Ashuelot R.	.	..	..	14	..	600	51	0	0	500	83,200	Small	Small	W. & S. Comrs.	2-90
Laconia	6.1	1890	Comb.	Winnipiseogee R.	.	5	¾	3	12	200	...	...	...	..	3,000	500	3	.....	10-90
Littleton	3.4	....	....	River	.	..	..	2	..	...	...	...	...	..	.....	....	....	St. Comrs.	5-91
Manchester, F	44.1	....	Comb.	Merrimac R.	64	..	..	20	8	2,000	251	100	1,202	47	.....	....	....	Com. Cy. C.	2-91
Milford, F	3.	1889	Comb.	Souhegan R.	.	..	0	½	10	...	15	7	9	..	.....	....	....	Selectmen	12-90
Nashua	19.3	....	....	M'mac & Nash. Rs.	.3	15(b)	10(b)	40(b)	10	...	15	12	1,200	..	.....	1,500(b)	400	Com. Cy. C.	10-90

F. Flushing Devices.—Milford flushes from hydrants; at Manchester a brook discharges 1,000 gallons per minute into sewer; Keene has 52 Field flush tanks, discharging 140 gallons at intervals of one to six hours; four towns do not report.

VERMONT.																			
Barre, F	6.8	1890	Sep.	Stevens' Br.	9	8	..	½	7	8	400(b)	87	0	0	0	75,000	0	50	.....	3-91
Bellows Falls, F	3.1	....	Comb.	Conn. R.	2¼	16	1	5	8	100	42	42	20	..	18,000	....	50	.....	5-91
Brattleboro	5.5	1874(k)	Sep.	Conn. R.	.	..	..	..	6	...	...	...	...	..	.....	0	0	Bailiffs	3-91
Burlington	14.6	1875	Comb.	L. Champlain	.	53	7	13	10	...	93	(l)	125	61	.....	....	....	Com. Cy. C.	10-90
St. Johnsbury	3.9	....	Comb.	Passumpsic & S's Rs	.	..	1-6	3(b)	..	...	6	...	...	..	.....	....	....	.....	5-91
Springfield, F	1.5	....	Comb.	Black R.	.	..	0	¼	..	20	...	...	...	..	2,000	....	....	Trustees	2-91
Vergennes, F	1.8	....	Sep.	Otter Creek	2	7	1	2	8	100	0	0	0	0	.....	....	....	Cy. C.	2-91

F. Flushing Devices.—Barre and Vergennes flush from hydrants; Bellows Falls flushes from a brook, two springs and seven pipes; Springfield flushes from a brook; Burlington has no flushing devices; two towns do not report.

MASSACHUSETTS.																			
Amesbury, F	9.8	1885	Sep.	Powow R.	4	20	..	½	1½	..	...	18	...	...	..	.....	....	....	Selectmen	3-91
Attleboro	7.6	....	Comb.	Ten Mile R.	..	..	0	1	1½	12	50	25	25	32	..	12,000	0	0	Selectmen	3-91
Boston, F	448.5	....	Comb.	Harbor (m)	35	410	240	316	..	10	...	...	...	8,000	..	.....	23,771	49,372	.....	1-91
Brookline	12.1	1877	Comb. (n)	Chas. R. & Alewife Br	6½	77	24	84(p)	8	...	...	...	...	...	0	614,746	1,018	2,986	.....	2-91
Cambridge	70.	1845	Comb.	Charles R. (o)	6½	46(p)	23(p)	33	..	...	...	...	1,824	..	1,041,313	....	5,000	.....	10-90
Chicopee, F (f)	14.1	1884	Comb.	Conn. & Chic. R's.	..	..	..	10	..	...	...	...	...	..	105,000	....	....	Selectmen	1-91
Clinton	10.4	1889	Sep.	Nashua R.	8	32	..	..	3¼	8	...	130	0	0	0	40,000	0	....	Road Comrs.	12-90
Easthampton	4.4	1876	Comb.	Manhan R., Will'n P.	4	..	0	..	..	6	...	...	...	...	..	15,000	400	....	Road Comrs.	2-91
Fall River	74.4	1873	Comb.	Bay, Taunton R.	36	105	20	34	12	2,243	1,197	....	427	31	972,564	0	0	.....	10-90
Fitchburg	22.	....	Comb.	Nashua R.	28	117	3	15	8	1,500	289	289	200	0	163,210	....	....	.....	3-91(r)
Gr't Barrington, F	4.6	1888	Sep.	Housatonic R.	1	..	0	1	1-5	6	100	20	0	5	0	15,000	200	200	Comrs.	3-91
Greenfield	5.3	1881	Comb.	Green R.	1½	15(b)	2(b)	5(b)	..	...	750(b)	...	...	...	...	.....	....	....	Selectmen	2-91
Haverhill	27.4	1877	Comb.	Merrimac R.	24	102	5	18	..	8	2,000(b)	201	0	400(b)	0	200,000(b)	0	1,500(b)	Com. Cy. C.	12-90
Holyoke	35.6	....	Comb.	Conn. R.	36	40	3	..	..	10	...	...	...	...	...	.....	0	1,275	S. Com.	10-90
Lawrence, F	44.7	1850	Comb.	Merrimac R.	7	66	5	33	..	10	...	509	509	630	0	559,964	....	....	St. Comr.	10-90(s)
Leominster	7.3	1874	Comb.	Monoosnock Br.	.	..	1-25	3	..	10	150	100	100	25	0	35,000(b)	0	50(b)	.....	2-91
Lowell, F	77.7	1873	Comb.	Mer. & Concord R's.	13	120	23	55	..	12	...	1,250	1,250	1,420	30	1,571,200	....	6,000	S. Com.	12-90
Lynn	57.7	1866	Comb.	Harbor	11	110	45	31	..	8	2,800	...	16	600	0	725,000	1,593	1,668	Com. Cy. C.	12-90
Marlboro	13.8	1891	Sep.	Hop Brook (t)	.	..	..	..	..	6	...	...	...	...	..	.....	....	....	S. Com.	12-90
Middleboro	6.0	1885	Comb.	Nemasket R. (u)	4½	..	..	..	¾	6	20	...	...	...	..	3,000	....	....	Selectmen	11-90
Milford	8.8	....	Comb.	Charles R.	2	..	..	1	..	..	100(b)	9	9	19	0	3,500	0	60	.....	12-90
Nahant	.9	1882	Sep.	Ocean	1	..	..	10	..	6	200	150	...	3	..	60,000	....	100	.....	3-91
New Bedford, F	40.7	1852	Comb.	Acushnet R., Cove	..	105	40	40	8	...	262	220	375(v)	0	552,092	....	....	Bd. P. Wks.	3-91
North Adams, F	16.	1879	Sep.	Hoosac R.	.	..	0	7	6	...	...	...	...	..	40,000	0	75(w)	Selectmen	4-91
Northampton	15.	....	Comb.	Mill R.	.	..	3	..	..	...	210	100	...	..	.....	....	....	Comrs.	3-91
Plymouth	7.3	....	Comb.	Brook and harbor.	.	..	..	..	..	8	...	0	0	0	0	.....	....	0	Selectmen	11-90
Salem, F	30.8	....	Comb.	Harbor	9	60	15	25	8	...	200	...	550	0	.....	1,000	1,000	St. Com.	5-91
Somerville, F	40.2	....	Comb.	Chas. & Mystic R's.	4	44	33	44	6	...	736	736	...	0	782,000	1,984	3,210	Com. Ald.	10-90(x)
S. Framingham, F	9.2	1889	Sep.	(y)	.	..	2	5	8	128	138	0	0	0	146,000	....	....	.....	10-90
S. Hadley Falls	4.3	1885	Comb.	Conn R.	2	6½	2-5	2 3-5	8	122	31	31	212	..	13,717	0	63	Selectmen	5-91
Spencer, F	8.7	1885	Sep.	(z)	2-5	10	0	5	8	300	50	0	...	..	45,000	0	30	Supt. S.	2-91
Springfield, F	44.2	1873	Comb.	Conn. R.	34	320	15	50	8	...	500	(a')	2,000	0	619,890	....	....	Supt. S.	10-90(b')
Taunton	25.4	....	Comb.	Taunton R. & Str.	48	160	10	9	12	...	27	0	360	0	.....	47	187	Supt. Sts.	2-91
Turner's Falls	...	1886	Comb.	Conn. R.	1	5	..	4½	..	...	...	...	...	..	75,000	....	....	Selectmen	12-90
Ware, F	7.3	1889	Sep.	Ware R.	1	8	0	7	6	86	152	152	17	4	45,368	....	....	Road Comrs.	10-90
Westfield, F	9.8	1890	Sep. (c')	Westfield R.	5	..	0	2½	6	150	104	104	...	..	50,000	....	....	.....	3-91
W. Springfield	5.	....	Comb.	C. & Agaw'n R's (d')	.	..	..	4 1-3	10	...	...	...	...	..	53,000(b')	....	....	Supt. Sts. & S.	5-91(e')
Williamstown	4.2	1883	Sep.	Hoosac & Green R's.	2	6 1-3	⅛	6 3-5	5	80	4	2	2	3	.....	....	....	(f')	12-90
Worcester	84.7	1869	Comb.	Blackstone R. (g')	11	90(h')	37(b)	71	9	2,275(i')	2,736	(j')	1,529	0	2,616,975	(k')	(k')	Com. Cy. C.	10-90

F. Flushing Devices.—Chicopee, Lawrence, Lowell, New Bedford (infrequently), North Adams, Salem, Somerville, South Framingham (plugs, manholes), Spencer and Ware flush from hydrants; Great Barrington and Westfield from brook (Westfield from four points once in 14 days); Boston uses "gates, hose, etc."; Amesbury has five automatic adjustable devices, and Springfield has 45 devices, neither place stating kind more explicitly; 11 towns have no devices; Haverhill reports practically none; 12 do not report.

RHODE ISLAND.																			
Central Falls	..	1885	Comb.	Blackstone R.	10	..	..	..	5	8	75	100	100	100	50	100,000	....	200	Town C.	3-91
E. Providence	8.4	1884	Comb.	Seekonk & Pawt. R.	.	..	..	1-3	10	25(b)	6	6	19	0	11,500	....	250	Town C.	12-90
Newport, F	19.4	....	Comb.	Bay (l')	.	77	40	26	6	(m')	(n')	(n')	275	0	150,000	....	....	Com. Cy. C.	2-91
Pawtucket, F	27.6	1884	Comb.	Seekonk R. (o')	9	..	..	16	8	889	411	411	341(p')	205	354,000	0	1,888	S. Comrs.	3-91(q')
Providence, F	132.1	1871	Comb.	R's, Harbor	16	168	122	63	12	7,160	3,107	3,107	2,153	(r')	2,135,439	1,300	13,000	Com. P. Wks.	1-91
Warren (Co.)	4.4	1884	Sep.	Warren R.	.	..	..	..	½	6	...	0	0	0	0	....	94	.....	-91

F. Flushing Devices.—Providence flushes from hydrants; Newport has one Waring flush tank, and Pawtucket has 57 Rogers-Field flush tanks; two towns have no devices and one does not report.

CONNECTICUT.																			
Birmingham	4.4	1889	Comb.	Tidewater	2	6	..	½	..	..	...	...	...	...	..	.....	....	....	St. Com.	5-91
Bridgeport	48.9	1865	Comb.	L. I. Sound	11	140	56	53	12	...	...	0	779	0	.....	(s')	(s')	Bd. P. Wks.	5-91
Greenwich	10.1	1882	Comb.	L. I. Sound	1	8	¼	2¾	6	...	22	12	0	0	10,000	232	0	Com.	5-91
Hartford	53.2	....	Comb.	Conn. & Park R's.	19	100	66	48	12	...	...	437	...	..	608,465	770	....	St. Comrs.	10-90(t')
Middletown	9.	1869	Comb.	Conn. R. & tributary	.	18	2	8	8	...	1,115	370(b)	61	2	132,418	609	447	S. Com.	3-91
New Britain	19.	1873	Comb.	Pipe & Shuttle M. Br	4	35	4	15	8	...	183	0	162	0	.....	Small	....	S. Comr.	3-91(u')
New Haven, F	81.3	....	Comb.	Harbor	9	140	32	59	9	...	1,750(b)	few	1,100	0	.....	....	1,545	Bd. P. Wks.	10-90(t')
New London	13.8	1887	Sep.	Harbor	4 1-3	..	..	7 1-3	8	487	180	180	0	..	80,756	....	....	S. Comrs.	10-90(t')
New Milford	1.1	1874	Comb.	Housatonic R.	.	..	..	2½	6	...	...	...	...	..	6,000	....	....	Selectmen	3-91
Norwalk, F	17.7	1887	Comb.	Harbor	1 2-3	23	2	12	12	650	290	290	140	0	160,000	225	744	.....	5-91
Norwich	16.2	1869	Comb.	Rivers (w')	.	37	3	12	8	...	360	170	495	76	150,000	246	1,062	Com. Cy. C.	10-90(t')
S. Norwalk, F	...	....	Comb.	L. I. Sound	5	13	1	5	..	...	195	195(x')	79	..	45,000	300	500	.....	4-91
Stamford	15.7	1887	Sep.	L. I. Sound	.	..	..	5	6	150	...	...	...	..	125,000	....	....	.....	3-91
Waterbury, F	28.6	1882	C. S.	Naugatuck R.	4	40	2	21	8	1,735(y')	...	all	222	3	350,000(z')	0	....	S. Comrs.	4-91
Willimantic, F	8.6	1888	Sep.	Natchaug R.	2	15	0	5	6	...	90	90	...	..	.....	....	....	S. Com.	5-91

F. Flushing Devices.—Norwalk flushes from hydrants; New Haven and Waterbury use portable tanks; South Norwalk uses Van Vranken flush tanks and Willimantic has five Rhode-Williams flush tanks, discharging 240 gallons every 12 hours; seven towns have no devices and three do not report.

(a) And into a tributary, Kenduskeag stream, until intercepting sewers are completed. (b) Estimated. (c) Partially estimated. (d) Houlton Sewerage Co., connected with Houlton Water Co. (e) Part of sewage used as fertilizer. (f) First record in 1857. (g) Discharged into tide water; mean rise and fall 9.1 ft. (h) Since Nov. 30, 1887, 917. (i) Since Jan. 1, 1890, $239.-973. (j) York Beach Sewerage Co. (k) In 1874 village took possession of private sewers. (l) Nearly all. (m) Sewage is pumped. (n) Working toward separate system. (o) To pump into Metropolitan system, when finished. (p) Figures for Dec. 1, 1889; all streets opened and sewered are not accepted. (q) Chicopee Center and Falls. (r) Figures for Dec. 1, 1890. (s) Figures for Jan. 1, 1890. (t) Intermittent downward filtration. (u) Sewage discharged upon land near river. (v) In addition there are 101 "eye holes." or direct intakes. (w) $75 for flushing. (x) Figures for Jan. 1, 1890. (y) Irrigation and intermittent downward filtration; pumped to the beds. (z) Sewage discharged into sand bank, thence into river. (a') Nearly all. (b') Figures for Dec. 10, 1889 (c') Not more than 5 per cent. of rainfall reaches sewers. (d') Hand worked gates exclude high water from sewer, at which times pumping is used. (e') Figures for Jan. 1, 1891. (f') Board of Health and Trustees of Williams College. (g') Chemical precipitation. (h') In addition, 60 miles private streets. (i') Oct. 10, 1890. (j') Nearly all. (k') $14,000 for both repairs and cleaning. (l') Sewage carried across inner harbor through 30-in. inverted siphon. (m') 1,245 connections since began issuing permits, in 1884. (n') All new sewers have manholes, ventilated. (o') Sewage from Moshassuck district to be pumped and filtered. (p') 41 gutter inlets in addition. (q') Figures for Dec. 1, 1890. (r') Few; doing away with them. (s') $2,850 for both cleaning and repairs. (t') Figures for Jan. 1, 1890. (u') Figures for April 1, 1890. (v') $138 for both repairs and cleaning. (w') Thames, Shetucket and Yantic rivers. (x') Some being closed. (y') Jan. 1, 1891. (z') Dec. 31, 1889.

fact that the proper official failed to respond to the inquiries sent, and the person who filled in the blanks was obliged to omit many answers. For the same reason many of the figures are only approximate. The information is presented for just what it is worth, and we think that for general purposes of comparison this will be considerable.

Our inquiries have revealed, or made much more apparent, the neglected condition of city engineering in many municipalities and the vast amount of improvements yet needed in all. How great this lack of improvements is can be seen, in part, by comparing the figures of the three columns of the table which give the total length of streets opened and accepted, the length paved or macadamized, and the length of sewers.

Of the 88 towns included in the table, 65 report regarding paving, and of this 65, 17, or about 25 per cent., have no paved or macadamized streets, and 10 towns, some of which are small, have less than a mile of streets improved as named. Of those that do not report on this point probably most have but a small mileage of improved streets and some not any. Boston and Somerville, Mass., Newport, R. I., and Hartford, Conn., are the only cities reporting over half their street mileage paved or macadamized.

Comparing the length of sewers with the total length of streets we must first bear in mind that no cities without sewers are included. But there are eight of the 80 towns stating length that have less than a mile of sewers.

It is well known that as a rule New England cities and towns are in good financial condition, but, whatever the cause, they are certainly backward in street improvement and sewerage, nor is it likely that other sections of the country will show more enterprise in these respects when the figures for them are tabulated.

The column in the table giving the smallest size of sewer pipe used shows that several cities use 6-in. pipe, but mostly in connection with separate or small combined systems. At Williamstown, Mass., 5-in. pipe is used in a separate system with only ¼-mile of pipe. Of 70 cities reporting 20 give no pipe below 10 ins. in diameter.

In the matter of manholes there are four separate systems, all small, that have none. Of the 84 remaining systems 22 have all manholes ventilated, 14 have some, but not all, 13 have none ventilated, and 32 do not report. South Norwalk, Conn., reports that the ventilators of some manholes are being closed.

Lamp-holes are not generally used, only 17, or about one-third, of the 49 towns reporting using them at all, and these towns having but very few. Keene, N. H., with a separate system built in 1883, has 500 lamp-holes on 14 miles of sewers, or about 36 per mile. Providence, R. I., reports that it has a few, but is doing away with them.

The cost of cleaning and repairing sewers is not reported very fully, nearly half of the towns omitting to give these items. Of the 45 towns that answered the question regarding repairs 18 stated that no money was spent for this purpose during the fiscal year nearest the date of report. Of the 48 towns that reported on the cost of cleaning only 7 reported no money spent for this purpose during the year. Some of the towns reporting on cleaning specified that the sum included the cost of flushing; others did not mention flushing; some have to pay for the water used in flushing and some do not; in some towns we have reason to believe that the cost of cleaning catch-basins is included in the cost of cleaning sewers, while in others it is not; the figures for cleaning, therefore, are hardly suitable for any except the most general comparison. In addition, the need and cost of cleaning depend so largely upon local conditions, and the amounts spent for these purposes and repairs vary so largely with the character of the general management of the systems that comparisons of either the cost of repairs or cleaning can at best be of little value, unless a few cities are selected by a person fairly familiar with all the local conditions.

Boston, with 316 miles of sewers, reports a yearly expenditure for repairs of $23,771, or an average of about $75 per mile for the total mileage. For cleaning, Boston's expense was $49,372, or an average of $156 per mile. Taking a smaller city, Pawtucket, R. I., whose sewerage system is believed to be well managed and is comparatively new, having been built in 1884, we find no expenditure for repairs, and $1,383, or about $86 per mile, for cleaning. Boston uses "gates, hose, etc.," for flushing, and Pawtucket uses 57 Rogers-Field flush tanks, or one for each 3 9-16 miles.

Of the 60 towns reporting, 20 flush sewers from hydrants, 9 from brooks, pipes, gates, hose or portable tanks; 7 from automatic flush tanks, 2 flush, but do not state in what manner; 22, or over one-third of those reporting, have no flushing whatever.

That the above showing is not more favorable is to be explained as follows: Except in large cities, sewerage systems are of recent introduction, for of the 61 towns reporting when the construction of their sewerage systems was begun, 38, or nearly two-thirds, state that it was since the beginning of 1880, against 23 before that date. Roughly speaking, not half of the towns now supplied with water had water-works before 1880, and of course sanitary sewers are impossible prior to the introduction of a public water supply. Water-works come first, and the financial resources of many towns are often, for a longer or shorter time after providing these, so low that sewerage construction is, or is considered to be, impracticable. Many citizens, of smaller towns especially, do not use the public water supply and thus do not care for sewers; but all wish fire protection, and so the water mains are extended faster than the consumers increase, and the water-works expenses mount up more rapidly than the revenue, exhausting funds that might be used for sewerage construction and retarding progress in this direction. In addition to the above, many people who use city water prefer to continue to discharge their house drainage into cesspools rather than to pay their share of the cost of sewering the street on which they live. And still further, the general public is exceedingly slow to realize the necessity of sewers or other sanitary improvements, as all who have worked in the interests of good sanitation know far too well.

For the past year or two much sewerage construction has been going on all over the country, both in the way of extensions and new systems. Sewage disposal, which will be considered for the whole country together, is receiving marked attention, and in a few towns has been satisfactorily introduced. Accompanying the agitation regarding sewage disposal, as would be expected, we see the separate system gaining in favor. In general, sewerage construction is more in accord with engineering principles, based on both American and foreign practice, than it was only a short time ago.

Other details brought out by our inquiries have been reserved for later consideration, as best suited for treatment in connection with the systems of the other groups of states.

The facts for the Middle States will next be presented, then for the Southern and other groups, until the whole United States has been covered, which will be done as rapidly as the demands upon our space and the necessary labor involved will permit.

TABLE 1.

Table Showing by Geographical Divisions the Number, Tonnage, Value, Freight Movement and Number of Employees of all Craft Registered in the United States, Dec. 31, 1889.

Geographical divisions.	Total craft.	Tonnage.	Value, 1=1.000	No. employees.	Tons of Freight moved.	No. tons freight moved per employee.	Capital invested per ton of freight moved.
Atl. coast..	12,453	2,,94,440	$123,874	54,859	77,597,626	1,415	$1.59
Gulf of Mex.	1,008	7,566	3,851	3,891	2,864,956	736	1.35
Pac. coast..	1,842	442,939	23,067	15,809	8,818,363	557	2.61
G't Lakes..	2,784	926,355	48,941	15,883	53,424,432	3,361	0.91
Miss. Val...	7,453	3,393,380	15,335	15,996	29,405,046	1,838	0.52
U. S.....	25,540	7,633,676	$215 069	106,436	172,110,423	1,617	$1.25
All U. S. Rys.			$9,323,465	750,000	619,137,237	826	$15.00

The above figures are compiled from the Bulletin, which has been issued by the Census Office, and which contains a vast amount of information regarding the transportation by water in the United States. The figures are the result of a most careful and laborious collection and compilation, and are the most complete and accurate that have ever been published. They are, however, naturally incomplete in some particulars, but they serve to show the magnitude and importance of the industry. The figures given do not include the operations of canals, and only relate to craft of American ownership, and, with the exception of some of the unrigged craft (barges and scows), to such only as are registered in the ports of the United States. Owing to the impossibility of securing reports for the fiscal year ending June 30, 1890, in time to prevent delay in publication, the figures cover the calendar year of 1889.

It will be seen from Table 1, compiled from the figures given in the Bulletin, that there are 25,540 registered craft of all kinds, having an aggregate tonnage of 7,633,676 tons, an estimated commercial value of $215,061,000, and giving work to 106,436 employees. These craft are divided into steam vessels, sailing vessels and unrigged craft, numbering 6,067, 8,912 and 10,561, respectively, and having a tonnage of 1,820,386 tons, 1,795,443 tons and 4,017,847 tons, respectively. The large preponderance of unrigged craft, both in number and tonnage, is especially noticeable, and clearly indicates the character of the traffic. In 1888 the entire tonnage of the shipping under the British flag was 9,050,000 tons, furnished by 27,906 vessels, only 1,416,324 tons greater than that shown by the above figures. Over one-half, or 4,615,000 tons, of this tonnage, however, was furnished by steam vessels, mostly seagoing craft. The aggregate amount of freight moved is given by the figures as 172,110,423 tons, or a little less than one-fourth of the aggregate freight movement of the railways of the United States for 1889, which was 619,137,237 tons. Taking 450 miles as the average distance of transportation for all classes of craft, which will probably roughly approximate to the actual distance, of which no figures are available, we have a ton-mileage 73,449,690,000 for water transportation in the United States outside of canals. The freight ton-mileage of railways in the United States for 1889 was 68,604,012,000, or 4,845,688,000 ton-miles less than for water transportation, calculated on the above basis, which is probably rather under than over the actual figures.

The capital invested per ton of freight moved varies from 52 cts. in the Mississippi Valley, where a very large proportion of the craft are unrigged scows and comparatively cheap end-wheel steamboats, to $2.61 on the Pacific coast, where the traffic is carried on mainly by seagoing steamers and sailing vessels. The small investment of capital per ton of freight moved on the Atlantic coast as compared with the Pacific coast is due to the large proportion of unrigged craft, over 26% of the whole, used in the harbors and along the navigable rivers on the Atlantic coast. The number of tons of freight moved per one employee is the greatest on the great lakes, doubtless because of the character of the traffic, which, being mostly grain, coal and ores, is easily and largely handled by machinery.

In Table 2 is shown the tons of freight moved by all classes of craft during the year.

TABLE 2.

Table Showing the Freight Movement in Tons of all Classes of Craft Operating during 1891.

Geo'phical divisions.	Total all craft.	Steamers.	Sailing vessels.	Unrigged craft.
Atl. coast.	77,597,626	28,778,341	38,283,401	10,535,884
Gulf of M.	2,864,956	1,455,450	1,359,526	49,980
Pac. coast.	8,818,363	5,741,940	2,761,826	314,597
G't Lakes.	53,424,432	20,181,483	19,302,949	13,940 000
Miss. Val..	29,405,046	10,345,504	.....	19,059,542
U. S....	172,110,423	66,502,718	61,707,702	43,900,003

TRANSPORTATION BY WATER IN THE UNITED STATES.

Transportation by water in the United States is a vastly greater industry in proportion to rail transportation than most people realize. It is doubtful if its ton-mileage does not exceed the railway ton-mileage. The eleventh census is the first to attempt to collect complete statistics of all classes of transportation by water in the United States, and while the figures (recently issued in Census Bulletin No. 179) are naturally incomplete in some particulars they serve to show the magnitude and importance of the industry. The figures given do not include the

A traction engine for hauling circus cars has been built by the J. I. Case Machine Co., of Racine, Wis. The boiler is of the locomotive type, with a cylinder on top 8½x10 ins., driving by gearing the two rear wheels 5 ft. 6 ins. diameter and 16 ins. wide. The two front wheels are 4 ft. diameter and 6 ins. wide, and are carried upon a swiveling axle, by which the engine is steered. On each side, in front of the driving wheels, is a water tank, the combined capacity being 500 gallons. The engine weighs 7 tons. Traction engines for hauling, logging and plowing were noted in our issue of May 5.

LETTERS TO THE EDITOR.

PRACTICAL EXPERIENCE WITH CEMENT JOINTS.

Sir: When the water-works at Kalamazoo, Mich., were built, there was a quantity of cast iron pipes (perhaps a mile) which had been previously laid with cement joints. This was connected with the pipe system, and used under the same pressure as the lead-jointed pipe (75 to 150 lbs. per sq. in.) No breaks or leaks occurred in it. I have when short of lead alternated lead and cement joints, and I have never had a cement joint blow out, but have had pipe broken from the cement making the joint too rigid. Yours truly, G. W. Pearsons.

Kansas City, Mo., May 11, 1892.

THE INVENTION OF DISCONTINUOUS DRAWBRIDGES.

Sir: In your recent issues there have been several claims as to priority of the invention for constructing drawbridges that shall be discontinuous when they are closed; in other words, having the two arms so connected over the center that when the span is swinging they shall act continuous, and when the draw is closed, they shall act as two disconnected spans. It is very difficult to say who is the inventor of any one idea, but here it would perhaps be just to say that the late Mr. C. Shaler Smith proposed the idea in the year 1880. I inclose a print showing the general outline of a drawbridge built by this company in the year 1888, which embodies the idea suggested by Mr. C. Shaler Smith. Yours truly J. W. Schaub.

Detroit, Mich., May 11, 1892.

(The drawing shows practically two independent trusses of 70 ft. span each with a toggle-joint connection of the upper chords, substantially as in our like plans recently published.—Ed.)

THE G. B. FISHER RAIL JOINT AND CHAIR.

Sir: I do not think you fully understand the Fisher safety chair (fastener) and rail joint support described in Engineering News of April 28, page 441. You state that "experience with metal ties has shown that they do not require tie-plates." It is true that they do not, provided you can fasten the rails to the ties in a simpler and more effective manner. There are various designs of metal ties, but there is nothing, so far as I am informed, to fasten the rails to them, that has given satisfaction. They have too many clips and bolts to be looked after, and these, when a rail has to be taken up, cause a large amount of extra and unnecessary labor. The excellence of a machine consists largely in having few movable parts.

An engineer in Belgium, in a report on metal ties, made about two years ago, stated that they were more economical and that he would recommend their use if there was some satisfactory way of fastening the rail to them. It is for this purpose that my chair is intended. On no railway in the country I think is there a rail fastener in use that has given satisfaction. If safe, they are complicated and give trouble to put the rails down or take them up. As to fish plates, I do not think that any rail joint is safe without them on rounding a curve. A 50-ton locomotive running at 40 miles an hour, upon striking the end of a rail on a sharp curve, is apt to bend the rail and leave the track. Cases of this kind have been reported.

My safety chair is not a tie plate, but a rail fastener and a rail joint supporter, for either metal or wooden ties. They do not weaken, but strengthen the ties, and hold the rails securely. Yours truly,

Chicago, May 14, 1892. G. B. Fisher.

(There certainly are some efficient and satisfactory methods in use for fastening rails direct to steel ties, including the Harvey grip thread bolts used on the New York Central R. R., as described in our issue of March 12.—Ed.)

"MILD" AND OTHER STEELS.

Sir: The structural material known as "soft" steel is receiving much attention from engineers at present. It is proper that it should, for it is probably the best structural material on the market to-day. "Medium" steel is also receiving a good share of attention, while "hard" steel is not much used for structural work. During the past few years a considerable amount of "mild" steel has been used, and the term "mild steel" has been applied rather comprehensively by some.

Now, at the risk of exhibiting an amount of ignorance, which may be both sublime and pathetic, the writer wishes to ask where the defining lines between "soft" and "medium" and "medium" and "hard" steels are conventionally drawn, for, of course, the terms are largely conventional. And is the term "mild steel" used to designate a material in any respect different from "soft" steel. Those who are familiar only with the constructive use of steel, and not with its manufacture, may be pardoned for a feeling of timidity regarding the definition of these terms.

In the handbook of Messrs. A. & P. Roberts & Co., "Wrought Iron and Steel in Construction," issued in 1885, it is stated that "the grades below 0.15 per cent. carbon are known conventionally as 'mild steels.'" On the same page the average ultimate tensile strength of steel containing 0.15 per cent. carbon is given as 66,000 lbs., and the elastic limit at 40,000 lbs., and as this statement came from prominent manufacturers of the material it was accepted by the writer as defining the limit of "mild" steel.

But during the next year (1886) Mr. C. Shaler Smith, C. E., in his specifications for the Sabula bridge across the Mississippi River, on the line of the C. M. & St. P. Ry., specified for the chords of the draw span (which Mr. M. A. Howe has published "as an example of one of the best draw spans in the United States,") "a good quality of mild steel, having an ultimate tensile strength of 90,000 lbs. per sq. in. or over, an elastic limit of not less than 45,000, etc." These specifications were supposed to have been fulfilled by the Edge Moor Iron Co.

Mr. Smith evidently used the term "mild steel" in a much different sense from that in which it was used by the manufacturers above quoted.

These conventional terms, applied to an important material, should have definite meanings within certain fixed limits, in order to be intelligently used and comprehended. They may have such meanings, but if so, they do not seem to be generally understood. Will some one rise and explain? Benj. F. La Rue.

Jackson, Mich., April 20, 1892.

(So far as we know, there is no general agreement among engineers as to the exact limits of tensile strength which distinguish steel as "soft," "medium" or "mild." The general usage seems to be about as follows: Mild steel is used, as shown by the quotation above, from C. Shaler Smith's specification, to express about the same meaning as "structural steel." It was the original term used to distinguish the structural steel first made from the hard tool and machinery steel which was, and to a large extent still is, the only steel with whose properties the non-technical public is familiar. Nowadays the term mild steel is sometimes used, we believe, interchangeably with "soft steel" to designate metal of not over 62,000 to 65,000 lbs. tensile strength. On the contrary, "soft steel" may be used as a general term for structural steel, though we do not think this use is common. "Medium steel" is a term used for metal of 65,000 to 75,000 lbs. tensile strength, more or less. On account of the uncertainty as to the exact meaning of these terms, their use in specifications is to be deprecated, and the exact limits of tensile strength (or of carbon, if preferred) should be stated to designate the quality of steel desired. If any of our readers can furnish evidence of other usage of these terms than that above stated, we shall be pleased to give space to their communications.—Ed.)

THE BOSTON SEWERAGE SYSTEM.

The report of the Boston Street Department for 1891 contains some very interesting matter regarding the sewer division, from which the following information is extracted. The future work of the department, the report states, will consist largely of sewering the suburban districts. Large areas of this district have been sewered, but many of the sewers are too small. This must be remedied and a general plan for new sewers devised.

In brief, it is considered best to utilize all natural water courses in the suburban districts for storm water, enlarging them as necessary to meet the increased flow of water accompanying the building up and improving of the suburbs. Finally the water courses will be paved and covered. This is a much easier method than constructing large storm sewers and often the only practicable plan, since small sums of money can be obtained from year to year for suburban work when large sums could not.

When water courses are available relief sewers can be introduced in connection with the combined system, or a separate system may be used with the storm water emptying into the streams.

Fig. 1 shows a section of the Dorchester Brook sewer. Fig 2 is a section of a very large sewer. Both of these sections appear in the report without description.

Fig. 3 is a section showing a cross-section of the new channel and retaining wall of Stony Brook, Washington St., at Roslindale. This channel is 665 ft. long, partly open and partly covered, a portion of its length across private land. The open portion is 12 ft. wide, except for the first 22 ft., where it is 9 ft. wide, with sidewalls of rubble masonry at least 6.8 ft. high. It has a grade of 1 in 100. The covered portion varies in size from 11½ ft. wide by 6½ ft. high to 9 ft. wide by 8½ ft. high. The sections show a width of 9 ft. and a height of 8 ft., and a grade of 1 in 56, or 1.8 per cent. The capacity of the channel at this point is about 800 cu. ft. per sec., and the drainage area tributary is 760 acres. A part of the closed channel has a grade of 1 in 100. The bottom of both the open and closed parts is paved throughout with stone or brick on a concrete foundation, the latter extending beneath the side walls.

The Boston main drainage works, or system of intercepting sewers, has now been in operation eight years. It was expected that sewage and gases would have a bad effect upon the ironwork in connection with the plant, but owing to uncertainty it was decided to use it and learn by experience. It has been found that parts of the iron of the pumps and gates, especially where subjected to friction, might better have been made of other, even though more costly, material. The iron valve-seats of the pumps are so badly worn that all of them must be renewed, this work being in progress at the time of the report. The gate-seats in the sewers at Moon Island are also worn and being renewed. The seats where the wear comes will be faced with a hard composition.

An excessive amount of water has to be handled by the pumps of the main drainage work, the average daily consumption of water in the section drained by these works in 1891 having been 35,686,900 gallons, and the amount pumped more than double this, or 62,582,683 gallons, after allowing a liberal percentage for slip. This excessive amount of water comes from catch basins on new sewers and the leakage of soil water into the system. The total length of sewers in Boston Jan. 31, 1892, was 331.6 miles, including 21.5 miles of intercepting sewers.

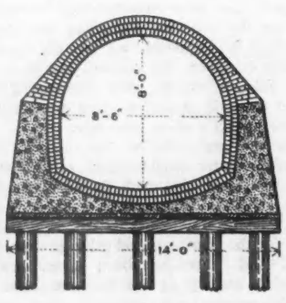


Fig. 1.
Dorchester Brook Sewer, Boston.

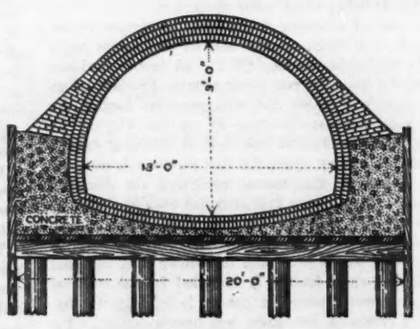


Fig. 2.
Section of Large Sewer, Boston.

NICKEL ORE IN OREGON.

The indications are that the as yet little worked nickel deposits in Oregon may prove of much greater value than has been anticipated. In our issue of April 28 we noted the organization of a company to develop nickel ore deposits in Oregon, and as the matter is of considerable importance in view of the use of nickel in steel manufacture, and the adoption

of nickel steel for armor plating by the U. S. Navy Department, we have made inquiries respecting the new enterprise. Nickel deposits have been known to exist for several years, and are said to closely resemble those of New Caledonia, which are the largest and richest now known, but the extent of the Oregon deposits was not investigated to ascertain if they were large enough to pay for working. The International Nickel Mining Co., of Chicago, has recently been organized, with a capital stock of $5,000,000, to establish works for the production of nickel from the Oregon ores, and the enterprise seems to be at least a promising one. The officers of the company are as follows: President, James R. Ashley, Joliet, Ill.; Vice-President, H. S. Gillette, Chicago; Secretary and Treasurer, W. H. Taylor, Chicago. The Directors are Louis F. Menage and J. B. Crooker, of Minneapolis, Minn.; J. R. Ashley, of Joliet, Ill., and S. Dreyer, V. H. Surghnor, J. C. Polley, H. S. Smith and W. H. Taylor, of Chicago. The company's office is in the Chamber of Commerce Building, Chicago. The mines are situated in Douglas County, near Riddles, Ore., about 160 miles south of Portland, and Mr. W. H. Taylor, the Secretary and Treasurer of the company, who is said to be an expert mineralogical chemist, has already gone out to establish a plant, the estimated cost of which is given as $150,000. Analyses of single samples of ore, made at the laboratories of the Illinois Steel Co. and Mariner & Hoskins, Chicago, gave 21.38% of nickel in one piece of ore in the first case, and 18.2% of nickel in 2,000 lbs. of ore in the second case. The following information has been furnished us by Mr. H. S. Gillette, Vice-President:

This nickel deposit, the largest and by far the richest yet discovered, was brought under the notice of Mr. Taylor and myself some three months ago. We immediately dispatched an expert to make an examination, and his report took us entirely by surprise. The nickel bed was found to be of considerably greater extent than was at first represented, and a conservative estimate to the effect that, taking out 500 tons of ore per day, there is enough ore body in sight to last for 20 years. The result of the analysis was still more surprising; one made by Mariner & Hoskins, of Chicago, shows 18.2 per cent., and one made by Mr. F. Julian chemist for the Illinois Steel Co., shows 21.38%. The percentage of nickel found in the mines of Sweden and Norway, the nickel fields of Europe, have not exceeded 2 to 3%, and in the celebrated Sudbury mines in Canada it has not exceeded 3%. I wish to point out that in both the old and the new world, up to the present time, the nickel has been found in such combinations that it has required an enormous amount of heat, for a period ranging from 10 to 30 days, to extract the metal. In our ore we can readily extract the nickel in two hours with an ordinary blowpipe, and the expense of working is, in consequence, reduced to a minimum.

The discovery of this deposit will bring nickel into far more general use than at present, and we thing that in many respects it is one of the most valuable mining discoveries of the age. We are within easy reach of a railway, and are constructing a first class road to the mines. We are pushing forward with all possible rapidity the erection of a plant capable of meeting every demand upon our production. Starting in on a 2-in vein and sinking a shaft 6 ft. into the side of the mountain, it opened up 18 ft. Our expert went round to the opposite side, and on the same vein, and started on a 2-ft. vein, and it opened up some 27 ft. in less than a 10-ft. shaft. It is the opinion of an expert that it is almost a solid mountain of nickel. We have sunk shafts from 10 to 30 ft. at different places on the mountain, and have run up against solid walls of nickel, the extent of which we are unable to give any adequate conception of.

The above facts, of course, are not in themselves sufficient to establish the comparative value of the Oregon deposits without some further particulars. As to the percentage of nickel, single specimens of the New Caledonia ore can be obtained which will assay 40 to 50%, but this occurs only in pockets, and the average obtained from the ore shipments is, we are informed, only 8 to 15%. Thus it cannot be assumed from the two tests that the Oregon ores will average any such richness as 18 to 21% of nickel, and more extensive prospecting than seems to have yet been made will be required to establish the extent of the deposits. The comparison of the smelting process with a blow-pipe analysis is vague and inconclusive, and it appears that the gangue of the New Caledonia ore (which is similar to the Oregon ore) contains very much more magnesia than that of the Sudbury ores, rendering the New Caledonia ore more difficult to smelt. In fact, it is stated that a plant capable of smelting 30 to 40 tons per 24 hours of the New Caledonia ore will smelt 100 tons of the Sudbury ore in the same time, and with a less consumption of coke. We may state here that the Sudbury and Swedish ores are pyrrhotite, or magnetic iron pyrites, containing nickel, while the New Caledonia and Oregon ores are genthite or garnierite. Wherever serpentine rock occurs nickel may be expected, but not necessarily in workable quantities, generally only as a trace.

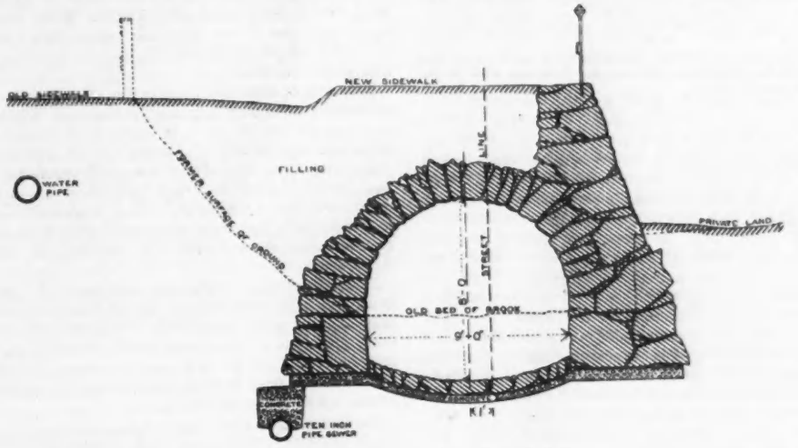


FIG. 3. STONY BROOK IMPROVEMENT.

NOTES FROM RECENT WATER-WORKS REPORTS.

The average daily consumption of water in Boston, according to the last report of the Water Board, for the 13 months ending Jan. 31, 1892, was 46,742,100 gallons, or 86 gallons per inhabitant. Over 25% of the total consumption was metered, or 4,391,570,900 gallons out of a total of 17,060,874,900 gallons. The total number of taps in use is 83,433, and of meters 4,245, or less than 5% of the taps. There are, however, 81 Deacon meters used to detect waste.

Very careful studies of the condition of the water at the various sources were made during the year, including observations and records of the temperature and the number of organisms at the surface, middle and bottom of the water in each water supply basin. The color of the water was also observed. These observations are commented upon by Mr. Desmond Fitzgerald, resident engineer and superintendent of the western division of the works, whose report is accompanied by photographic reproductions, made at the biological laboratory, of four micro-organisms, namely, asterionella, melosira, closterium and micrasterias. Those interested in the organisms found in water supplies would do well to secure a copy of the report, which, in addition to the information mentioned above in this connection, contains the means of monthly analyses of water from different parts of the works from June, 1889, to December, 1891. These analyses were made by Prof. Thomas Drown, of the Massachusetts Institute of Technology, Boston.

The report states that investigations for a new source of supply is under way, and that eventually a great metropolitan system may be expedient. Mr. Wm. Jackson is city engineer.

Newton, Mass., has the remarkably low consumption of 41 gallons per inhabitant, as shown by the last report of the Water Board. This is accounted for, at least in part, by the fact that nearly 70% of its taps are metered, or 3,269 out of 4,705. In addition, the amount of water used in manufactories is small, if the relative number of manufacturing and domestic meters is an indication, for of the 3,269 meters in use only 18 are on manufacturers' service. The 70% of metered taps pass about 42% of the total consumption, or 165,100,000 out of a total of 389,562,509 gallons.

Nearly the whole population at Newton is supplied with water, it being estimated that of 26,000 people 25,200 are on the lines of pipe and 24,700 actually supplied. Mr. Albert Noyes is city engineer and Mr. H. M. Hyde is superintendent.

A still lower consumption than that at Newton is reported by Waltham, Mass. In this city the average daily consumption per inhabitant is only 38.3 gallons, and per consumer 40.9 gallons. Moreover, there are only 46 meters in use as compared with 2,650 taps, or less than 2% of the taps are metered. Perhaps the previous lack of a sewerage system, just introduced, may in part account for this small consumption.

A well 40 ft. in diameter and 18 ft. deep was sunk through in the bottom of the filter basin in 1891 to increase the supply. The contract price was $480 per foot of depth, or $8,940 for the well. Mr. F. E. Shaw, Providence, R. I., was the contractor, he being the lowest bidder. Claims for extras have since been made, however, and are still pending. The highest bid was at the rate of $1,000 per foot of depth.

At Hartford, Conn., in 1891, a shortage occurred in the water supply from the storage reservoirs, although the rainfall was above the average for 17 years, 42.82 ins., was 2.85 ins. greater than in 1890, or 48.47 in 1891 and 46.62 in 1890. It was therefore necessary to pump a considerable amount of water from the Connecticut River from Oct. 3 to Dec. 8 and from Dec. 22 to 30. The shortage of stored water in a year of excessive rainfall is stated by the commissioners to have been due to a lack of storage capacity. In 1890 the rain was so distributed that it met the demands, there having been 14.83 ins. of rain in the four months, January to June, inclusive, when the melting snow helped to fill the reservoirs, while in the five months, May to October, inclusive, when the draft upon the reservoirs was heaviest, there fell 20.95 ins. In 1891 these relations were reversed, and there fell 20.85 ins. in the first four months and 15.83 ins. in the next five months of the year, much water running to waste for want of storage in 1891.

Steps are being taken to build a reservoir with a proposed capacity of 1,000,000,000 gallons, which will nearly double the storage facilities, now only 1,300,000,000, distributed among five reservoirs.

The shortage of water supply during a year of plentiful rain was experienced in many cities and towns besides Hartford, and partly from the same cause, an unusual and unfortunate distribution of the rain throughout the year. Mr. S. E. Babcock, engineer of the water-works at Little Falls, N. Y., attributed the shortage in New England and New York to the falling of the rain at such times and in such a manner that the bulk of it was gathered up by vegetation and did not find its way to the streams as freely as usual.

Accompanying a low stage of the water in the streams Mr. Babcock states that at Little Falls and elsewhere in that section of the country the water during the driest part of the summer had a very woody taste. This taste he attributes to the decay of woody fibers in the water.

The Water Board at Little Falls ordered that the stream supplying the town and the reservoir on it be cleaned of all logs, leaves and other debris. A force of laborers was therefore organized and this work performed. Beaver Creek and its branches were cleared of a large accumulation of logs, floodwood and other matter. Some of the logs were almost entirely decayed, showing that they had been in the stream for a great many years. Shortly after this cleaning the woody taste in the water disappeared.

AN EXPERIMENT WITH ALUMINUM.

A brief paper with the above title was presented at the San Francisco meeting of the American Society of Mechanical Engineers by Mr. W. W. Christie, of the Ramapo Iron Works. The author described two iron-aluminum alloys of great hardness, which were produced by him in experimental work. No practical use was ever made of them, and no further experiments were made to determine whether the alloys could be reproduced with regularity. The paper was of especial interest, because the general testimony of investigators is that the addition of aluminum to iron and steel tends on the whole to soften rather than harden the metal. (See Eng. News, March 1 and Oct. 11, 1890.) It is possible that the hardness of the specimens described by Mr. Christie was due to some other cause than the aluminum contained; but if the contrary is the case, the fact is a most important one and should be more fully investigated. We reprint the paper as follows:

The composition of the alloy was:

	No. 1.	No. 2.
Wrought iron turnings	10 lbs.	10 lbs.
Cast iron turnings	10 lbs.	5 lbs.
Steel rail chips	10 lbs.	15 lbs.
Ferro-silicate of iron and aluminum	2 lbs.	2 lbs.

The melting was done by a well-known brass founding firm in their brass furnace. In order to melt the mixtures very high temperature was required on account of the wrought iron, which requires 3,000°; so the crucible was covered with a carbon lid and coal heaped upon it. Even then about three hours' time was required to melt it, and after being melted the ferro-silicate of the iron and aluminum, which has been left out, was added, and thoroughly stirred in. The castings made were 1½ ins. diameter by 14 ins. long, cast in green sand without any charcoal facing, and after the skin of sand had been removed from the castings they were very smooth and clean.

Mixture No. 1 was very fluid when hot and white, but had to be poured quickly, as it soon cooled. No. 2 was not as fluid nor as white as No. 1. No. 1 made a very homogeneous casting; No. 2 not nearly so much so, and its fracture duller than No. 1, which latter was very bright. It may also be said that pieces of both mixtures which have been on my desk since April, 1890, when they were cast, have retained their original brightness, which speaks well for the small percentage of aluminum in them.

Mixture No. 1 could not be touched by a specially tempered cold chisel, the edge of which was destroyed. On No. 2 a tool maker used an hour's time cutting off but little, and during that time the tool required, I believe, five or six sharpenings. When heated to a high red heat they both crumbled when struck with a hammer. When heated to a dull red heat No. 1 was placed under a steam hammer, and though quite resisting, allowed itself to be flattened to about 1¼ ins. thick before crumbling. It gave better results when annealed over one night. No. 2, when heated in the forge to a dull red heat, could be flattened to about ¾ in. thick.

A piece of No. 1 was remelted and cast into the usual shape for tension tests. This piece, though but 8½ ins. long, was put in a Fairbanks testing machine, but as it was uncertain as to just how it would act, no extensometer was used for fear of the test piece breaking suddenly. Breaking occurred at a scale reading of 13,860 lbs. The piece broke, however, in the jaws of the machine, and in the larger section of the piece, as there was a flaw in it (cinder flaw). For fear of breaking the jaws of the machine the test ended here. After breaking the smaller section in the impact machine, the area was obtained by a planimeter as 0.31 sq. in., which makes the tensile strength per square inch at the time of breaking 44,710 lbs. This would probably have been considerably higher, but for the flaw and untrue grip of the jaws, which caused a combined transverse and torsional strain. The area of smaller section was less than that of the sound portion of larger section, hence its use. When placed on a Heisler impact machine, between supports 6 ins. apart, a weight of 25 lbs. falling 1¾ ins. was required to break a circular section of 0.31 sq. in.

Of course, it is not desirable to use the alloy for work requiring finishing, as it is too hard for that, except when done on a grindstone. No. 1 is much harder to grind than No. 2.

The ferro-silicate of iron and aluminum used was an ordinary commercial article, purchased in the open market, and whose composition the writer was unable to learn.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

IX.

(Correction.—In the last two lines of the first paragraph on p. 461, issue of May 5, the date of Prof. Eustis' death should read 1885 instead of 1855, and the statement that "since his death no professor of engineering has been appointed" is erroneous, Prof. Winfield S. Chaplin having been appointed to that position in 1885 and held it until he resigned in 1891 to accept the chancellorship of Washington University, St. Louis. The error arose from inadvertence, and an impression that Prof. Chaplin held another professorship.)

(These papers will be republished in book form, and corrections or proper additions are solicited, and can be made at any time.)

THE LAWRENCE SCIENTIFIC SCHOOL.

(Concluded.)

The documents last given seemed to leave the Scientific School fairly launched upon what, looked back upon from the distance of 50 years at least, would seem must necessarily have been a career of triumphant and growing success, for events have since shown what a great and rapidly growing demand for technical education existed, which for 14 years at least was to be supplied only by the Lawrence Scientific School and one or two weak and little known organizations in the wilds of central New York. With remarkable foresight Mr. Lawrence had sketched what experience has since shown was exactly the right plan for the needs of the hour. More than one hundred successful schools founded since his day (including almost every one ever started except, alas! his own) exemplify that "the three great practical branches to which a scientific education is to be applied are, 1st, Engineering; 2d, Mining, in its extended sense, including metallurgy; 3d, the invention and manufacture of machinery;" in other words, what we now call civil, mining and mechanical engineering. Mr. Lawrence even saw further as to just how these branches should be taught. "These must be deemed kindred branches, starting from the same point, depending in many respects on the same principles, and gradually diverging to their more special applications." All successful scientific schools are now modeled on these lines, which we risk nothing in saying were never before so clearly laid down. What is more, Mr. Lawrence distinctly outlined the correct relation to his proposed courses of what we may call the non-practical or non-professional sciences in these words, in which we venture to put two crucial words in capital letters:

Mathematics and chemistry, geology, mineralogy, and the other sciences investigating the properties and uses of materials employed in the arts, carpentry, masonry, architecture and drawing, are all studies which should be pursued to a greater or less extent IN one or all of these PRINCIPAL divisions. (The three subdivisions of engineering, as above quoted.)

Having rendered this great and double service of giving the money and telling how to spend it properly, and the corporation having solemnly "pledged its best efforts to carry faithfully into execution these enlightened suggestions," Mr. Lawrence himself appears to have ceased to interfere much with the details of the school, even by advice. He had turned over his foundation to a body of experts in education and naturally would not do so, beyond assenting, if asked, to whatever they advised as proper steps to his end. He was about that time much interested in politics; came very near being nominated for Vice-President the year after he founded the school. Early in the next year (1849) he went abroad as Minister to England, where he remained until 1852, when his equally famous brother died, and in 1855 he died, a noble specimen of the highest grade of American manhood. He died doubtless in the full belief that his expressed desires in regard to the Lawrence Scientific School were to be kept constantly in view, and that he had left in it a lasting and honorable monument to his memory. At that time, in fact, the school came nearer to accurately following the lines which he had laid down than it had ever done before or since; and by a singular coincidence was then rapidly approaching the zenith of its prosperity, from which it was so soon to fall. Why it did so is perhaps discoverable in this record of its management after its foundation.

As it happened, just at the time that the purpose to found the Lawrence Scientific School was maturing in the mind of its founder, in the fall of 1846, Prof. Louis Agassiz was coming to this country to deliver a course of lectures on zoology before the Lowell Institute. He was then 40 years old, already famous in his specialty, a truly great man, of winning and noble personality, who then seemed even greater than he really was. The purpose was immediately formed to retain him at Cambridge, if possible, as a professor of Harvard College, and what more natural than that the funds of the newly created scientific school should be availed of for this purpose? Is not zoology a "science"? What better start, then, for a new scientific school than to attach to it the most eminent scientist in the world in this particular line?

This was at once done, and in the "Senatus Academicus" of 1848 duly appears the name of "Ludovicus Agassiz, LL.D., Zool. et Geol., Prof. in Schola Scientiar. Laurentiana," among the 35 professors and 7 tutors (the majority of them still eminent and well known names) who then constituted the entire faculty of Harvard College. It has expanded since to number 211 professors and nearly 100 assistants, as shown in more detail in a comparative table given below.

Prof. Horsford, a chemist of real eminence (since more widely known to fame as the proprietor of a very superior acid phosphate), constituted the only other professor of the school, and he was not regularly attached to it, but to the general college faculty. The first circular announcing the opening of the school reads as follows:

The following courses of instruction will be given in the Scientific School* at Cambridge, during the second term of the current academic year (1847-1848), which commences on Friday, 25th of February next. The instruction will be given in lectures, recitations, or both, according to the nature of the study, and at the discretion of the instructor.

Candidates for admission must have attained the age of 18 years, must have received a good common English education, and must be qualified to pursue to advantage the courses of study to which they propose to give their attention. They must furnish satisfactory evidence of good moral character, and give bonds for the payment of all college dues.

Members of the School, on leaving it, will receive a certificate of the number of terms for which they have been attached to it, and the studies pursued by them.

The number and choice of studies to be pursued are optional on the part of the students, who will, however, be counseled on these points by the Faculty. Attendance on the lectures and recitations is voluntary. For this as well as other reasons the government of the University wish wholly to discourage the resort of young men to the Scientific School, who do not, in the opinion of their parents and guardians, possess that stability of character and firmness of purpose, which will insure a faithful performance of duty without academic discipline.

1. Chemistry.—Professor Horsford will continue to receive special students in chemistry, who will give their attendance in the laboratory from 9 a. m. till 1 p. m. daily, three times a week, or once a week, according to the wants and objects of the student. Professor Horsford will also deliver a full course of lectures on theoretical and practical chemistry in the course of the term.

2. Zoology and Geology.—Professor Agassiz will deliver a course of lectures "On the History of the Earliest Geological Ages," commencing with a brief illustration of the fundamental principles of geology, and followed by a detailed account of the oldest known condition of our globe, the formation of its first solid crust, the deposition of the most ancient strata, the first introduction of life upon its surface, and the changes it has undergone up to and through the coal formation.

The regular lectures in future are to consist alternately of a full course of zoology and geology, theoretical and practical. Besides the instructions of the lecture room, Professor Agassiz will afford to students access to his laboratory during certain hours, in order to show them how to observe isolated facts, how to determine living and fossil animals, and how to conduct the investigation of a regular series of combined phenomena.

For those who intend to make a further study in these sciences, excursions in the neighborhood will be made in term-time, and longer excursions in vacation to those parts of the country, near and remote, which offer the most instructive field of observation.

3. Engineering.—It has not yet been in the power of the Corporation to fill this department. It will be brought into operation as soon as possible.

* This institution has been called "The Scientific School" for convenient brevity. The first article of the plan, as adopted in February, 1847, is as follows: "There shall be established in the University an advanced school for instruction in theoretical and practical science, and in the other usual branches of academic learning, to be called the Scientific School of the University at Cambridge." After the munificent endowment of Mr. Lawrence, his name was added to the above designation. It has been deemed advisable by the Corporation, for the present, to limit the operations of the school to the department of physical and exact science.

The following courses of lectures delivered to undergraduates will be open to members of the Scientific School, viz.:

A compendious course on Mineralogy and Geology, by Professor Webster.

A course on systematic Botany according to the Natural System, by Professor Gray.

A course on Natural Philosophy, by Professor Lovering.

A course on the General Outlines of the Classification of the Animal Kingdom, and on Comparative Anatomy and Physiology, by Professor Jeffries Wyman.

Should a sufficient number of students require it, the following special courses will be given:

On Practical Botany and in Vegetable Anatomy and Morphology, with full Microscopic Illustrations of the Development, Growth, and Metamorphosis of the Elementary Organic Tissues, by Professor Gray.

On Experimental Philosophy, with instruction in the use of Philosophical Instruments, by Professor Lovering.

On Comparative Anatomy with Microscopic Illustrations, by Professor Jeffries Wyman.

Practical Astronomy and the use of Astronomical Instruments will be taught at the Observatory, by William C. Bond, Esq., Director, and Mr. Geo. P. Bond, Assistant Observer.

The Observatory is supplied with the apparatus for simultaneous magnetic observations, which will be intrusted to a class of students desirous of taking charge of it.

Instructions will be given in the Higher Mathematics and especially in Analytical and Celestial Mechanics, by Professor Peirce.

Private instruction in the various branches of Mathematics will be given to those desirous of receiving it, by competent instructors residing at the University.

The new Chemical Laboratory and the building for the department of Engineering are in progress of erection. It is expected that the former will be ready for occupation by September next.

The formation of a Museum of Natural History, on an extensive scale, will be immediately commenced, under the superintendent by the professors in the several departments.

The Mineralogical Cabinet of the University, the Rumford and Philosophical Apparatus, the Anatomical Museum, the Botanic Garden, the Observatory, and the Public Library, will be accessible to the students of the Scientific School.

There will be observed in the second paragraph of this circular the beginnings of that fatal policy, a low or merely nominal standard for admission, which has continued in this and many other scientific schools to this day, and which has invariably injured every school which has persisted in it. This we shall see more clearly when we come to consider requirements for admission. In the meantime we merely note that whereas, to enter the classical or undergraduate course at Harvard, a candidate must now be examined in 10 subjects, he can enter the scientific school by an identical examination in only 4½ to 5 of those same subjects, and those in the main the easiest ones. In other words, the scientific candidate is required to know no more about anything and much less about many things than the "regular student." Of course, this tends to lower the grade of work done in the course correspondingly, and to lower that is to lower also the prestige of the school.

In this the Lawrence Scientific School was but following the precedent set by its only predecessor, the Rensselaer Institute; but that was then a weak, poor and obscure institution. It has since retrieved this early error. The Lawrence Scientific School never has. Its fault in this was only a negative one, but it was most unfortunate that it did not set an example of a properly high standard of preparation, which its successors would have had to follow.

The more serious error was that here, in this very first circular, we see a radical departure from that scheme for a school of the practical and exact sciences which its founder had outlined and the college pledged itself to carry out. It is true that in the footnote to the circular above the corporation pledges itself to make prominent the "department of physical and exact science." Precisely what they meant by this term is not clear, but if they meant anything but zoology and geology by it the pledge was never fulfilled. The wording of the very first circular shows that there was no thought of making instruction in engineering the main feature of the school. Whether led off by the witchery of Prof. Agassiz's enthusiasm or by their own inability to foresee and appreciate the importance which instruction in the "practical and exact sciences" was soon to assume, the purpose to form such a school as had been outlined in Mr. Lawrence's deed of gift had been abandoned almost before it was formed, if indeed it was ever formed. It is now too late to determine the precise purpose which led to the resolution creating the school in 1846, but it seems possible that it was originally created with the express idea of attaching Prof. Agassiz to it as its leading feature; and that Mr. Lawrence's money but not advice was taken, when it came along later, to aid in carrying out a predetermined policy, without noticing that this policy did not correspond very closely with that outlined by the giver of the fund. This seems the more probable because we find no reference to, or quotations from, the letter which we have termed the "deed of gift" in any of the documents relating to the school. We were able to obtain a copy of it only by resurrecting an old newspaper in the college library (the Boston "Advertiser" of June 10, 1847).

In the next following year, 1848-49, the courses had been expanded from two to eight, and yet engineering had dropped out entirely. It was not even promised. The courses were chemistry, zoology, anatomy, botany, mineralogy, experimental philosophy, mathematics and astronomy.

In 1849 a committee of the overseers of Harvard College* was appointed to visit the school. Mr. Lawrence had then just made a further gift of $50,000 to the school, and presumably enabled it for the first time to offer a salary which would attract a competent professor of engineering, in addition to supporting the existing departments. Lieut. Henry L. Eustis, U. S. Engineers, who graduated from West Point in 1842 first in his class, was induced to resign and accept the appointment, which he held until his death in 1885, as already noted. "The great demand for the active services in the field of most of those eminently qualified as engineers," remarks the committee, "has until lately made it impossible to fill the department."

This is about all that is said about the new department of engineering. The older departments only are seriously considered. The greatest stress is laid upon the needs of Prof. Agassiz's department. He naturally wanted to develop the school in a zoological-paleontological direction, and accordingly we find this committee bemoaning at length the fact that, while the school has "a very few very valuable specimens in paleontology, especially an entire mastodon, nearly perfect," yet "in an institution like the Scientific School, a completely furnished cabinet in every branch must be in course of formation. No profound original researches can be pursued and no thorough progress made without it," etc.

Similarly, the committee bemoan the fact that Prof. Wyman, the eminent physiologist, had been compelled to discontinue his instructions in the scientific school, "because, apart from the medical profession, the number of individuals among us is yet but small who pursue physiology as a study."

Similarly, Prof. Horsford felt that the study of chemistry was not getting quite a fair chance. He had made important investigations in urinary calculi, the cause of blistering, the fat of a sea-turtle, the gall of a bear, and sundry other things of the same nature which the committee duly enumerates, but as to practical results in the attendance of students, he is compelled to admit that the result is unsatisfactory. For some reason or other, in A. D. 1849, not many men showed a living interest in the gall of a bear.

Prof. Gray, of the "Department of Botany," was suffering in the same way as Prof. Horsford, of the "Department of Chemistry," and the committee express sympathy for both, but still, "the committee would especially solicit the earnest and intelligent consideration of the board for the report and needs of Prof. Agassiz of the Department of Zoology and Geology." Of the special needs of the new department of engineering, or of allusion to the fact that the college was under a solemn and continuing obligation to give it the predominance over all others, as that on which the founder laid most stress in his deed of gift, there is not a word.

Nevertheless, the Engineering Department was now founded, and from now on it was to include a majority of the students for some 15 years, as was natural from the fact that it was the only course leading to a professional career (other than teaching) and which was not chiefly a research course. Four years after a professor of engineering had been appointed, in 1853, the first class (of 4) in engineering was graduated, and thereafter there was a healthy growth in this department for four or five years, as will appear from the following, Table IX., which is a complete table of the graduates of the school to date in each of its several departments.

*The committee consisted of Edward Everett, Dr. Martin Gay, Chas. Pickering, J. T. Teschemacher and Jas. Hayward, none of them men of "practical science," and none of them specially well qualified to report upon what an engineering school should consist of.

TABLE IX.—Graduates of the Lawrence Scientific School in all Departments, and in each Year, from its Foundation to Date:

Year	Eng.	Chem.	Zool.	Math.	Bot.	N. H.	Anat.	T'l
1851..	..	..	3	1	..	..	..	4
1852..	..	1	..	..	..	..	..	1
1853..	4	..	..	..	..	..	..	4
1854..	9	1	2	..	..	..	..	12
1855..	8	6	..	..	..	..	..	14
1856..	10	4	..	..	..	..	..	14
1857..	10	4	1	..	..	..	..	15
1858..	8	4	1	2	..	..	..	15
1859..	3	5	..	..	..	..	..	8
1860..	4	..	..	..	1	..	..	5
1861..	5	5	..	..	1	..	..	11
1862..	6	..	5	..	..	..	1	12
1863..	5	1	..	..	..	..	..	6
1864..	5	4	..	..	1	..	..	10
1865..	12	3	..	..	1	..	..	16
1866..	1	1	..	..	..	..	..	2
1867..	3	5	..	..	1	..	..	9
1868..	4	4	..	..	..	..	..	8
1869..	5	..	..	..	..	..	..	5
1870..	3	5	..	..	..	..	..	8
1871..	..	3	..	..	..	..	..	3
1872..	..	..	..	..	..	1	..	1
1873..	9	1	..	..	..	1	..	11
1874..	2	1	..	..	..	..	..	3
1875..	3	2	..	..	..	..	..	5
1876..	3	2	..	..	..	1	..	6
1877..	10	1	..	..	..	..	..	11
1878..	..	2	(Geol.)	..	..	3	..	5
1879..	..	..	1	..	..	1	..	2
1880..	2	..	..	..	..	..	..	2
1881..	1	..	..	..	..	1	..	2
1882..	1	..	..	..	..	1	..	2
1883..	..	..	..	..	..	4	..	4
1884..	1	..	..	..	..	2	..	3
1885..	4	..	..	..	..	..	..	4
1886..	..	1	..	..	..	1	..	2
1887..	..	..	..	..	..	3	..	3
1888..	4	..	..	..	..	..	..	4
1889..	..	..	..	..	..	1	..	1
1890..	4	..	..	..	..	2	..	6
1891..	1	..	..	..	..	1	..	2
Total.	150	96	13	3	5	23	1	261
Undergraduates in class of:								
1892..	1	1	1 (Elec. Eng.)		1 (Biology)	3		7
1893..	2	2	1 "	"	2 "	2		9
1894..	..	4	3 "	"	2 "	2		12
1895..	6	2	3 "	"	5 "	3		18

In addition to the regular students of the school who graduate as such, we are informed that "not a few of the best engineering students are registered all through their course as college students, and graduate as Bachelors of Art." There were three or four such in 1891, in addition to the one engineering graduate recorded. There are also an unusually large number of special students, last year 70 out of a total of 118 on the lists. These conditions obtain more or less at other schools, also, however, and beyond mentioning their existence it is impossible to make allowance for them.

By 1859, however, or within six years after the first class graduated, and only four years after Mr. Lawrence's death, the school had reached and passed its zenith as a school of engineering, and had really begun to decline, though this was not yet perfectly clear. In this year a visiting committee was appointed, as usual, and its report lies before us in the Boston "Daily Advertiser" of Jan. 29, 1859. He must be a dull reader who looks it over and does not see the cause of its decline and approaching collapse as a school of engineering. The report proper occupies only half a column, and yet, a sentence or two excepted, the whole of it is written only as a kind of prelude to a memorial from Prof. Agassiz, urging the committee to do what it can to get $50,000 more for a beginning of his museum of natural history. The only reference in the report to any department of "the art of converting the great sources of power in nature to the use and convenience of man" is in the following lines:

"The brief and significant report of Prof. Eustis, of the Department of Engineering, indicates how much that department is cramped in its powers of usefulness by the want of an adequate provision of the material means with which, in a school like this, so accomplished an instructor should be furnished, in order to do justice to his department, his pupils and himself."

The report of the next visiting committee, for 1860-61, is even more unmistakable in its evidence of where the trouble lay. Prof. Eustis had gone to the war, whence he was to return a much broken man, to hold but not to fill the chair of engineering until his death in 1885. And with him disappears from sight of the committee the whole "Department of Engineering" bodily. All allusion to its past, present or future existence disappears. The committee's report is full of the Agassiz museum only, after the first four lines, in which it absurdly declares that "the accompanying documents show the prosperous condition of all the various departments." How prosperous the "various departments" really were is revealed in the table just given. The committee goes on to say that "of these reports the most important is certainly that of Prof. Agassiz," which is doubtless true, as the engineering department did not report at all. But let us see what

these despised "other reports" really contained. For our immediate purpose the others are more important and they are also much sooner read through. They are but half a page long each; one from the "Rumford professor of chemistry," and one from —the Hersey professor of anatomy! "The Rumford professor respectfully submits" that "the whole number of students in the chemical department during the past year is 31, of whom 21 have been present this term. There were no candidates for degrees last year; 2 will offer at the close of this year." The Hersey professor of anatomy respectfully reports that "instruction has been given in the department of comparative anatomy by means of lectures, recitations and dissections; also by the study of the specimens in the anatomical museum." There had been no regular students and nine special students in attendance "during the year." Whether these attended all at once or more than once is not stated, but from the fact that one lonely graduate in the department of anatomy emerged next year (the first, last and only one in the history of the school), we infer that one of these students at least was constant in his attendance.

Hic jacet The Lawrence Scientific School. It is not dead, indeed, but sleepeth; hopeful of a resurrection of which there has been some little sign of late, but which has not yet come, and can never come until there is a complete abandonment of the fatal error which gave it its death-blow before it was born, yoking all sorts of incongruous things together because they come under the general name of "science," oblivious of the fact that they had less real connection with each other than they had with the study of Greek and Hebrew.' Certain time-honored sayings about riding two stools and falling to the ground, jack of all trades and master of none, "everything by turns and nothing long," and the like, might perhaps be effectively enlarged upon as giving in a nutshell the cause of the trouble, but the facts will better speak for themselves.

Our plan does not require us to follow the history of the school further, as we propose to sketch the earlier history only of a few of the leading schools, before taking up the presentation of comparative summaries and aggregates. But we may appropriately conclude this notice of the earlier history of the Lawrence Scientific School by a few notes as to its later history, if for nothing else than to show that the earlier history, as summarized, gives a fair idea of the permanent dominating policy of the school, with results which are before us.

The attendance at the school was:

In 1853-4,	69	students,	36 in engineering.
" 1864-5,	72	"	36 " "
" 1865-6,	79	"	(maximum).

It is a remarkable fact that up to 1866, when the school had had 147 graduates (against only 112 in all the years following), no less than 94 had become professors or teachers. Whether this is really to the credit of the school or not, regarded as a school of practical science, we leave every one to judge for himself. It is certain, however, that Mr. Lawrence's expressed desire was to found a school to train workers rather than teachers.

In 1881 the report of the usual visiting committee says:

"The only teachers belonging solely to the Scientific School are Prof. Eustis and Mr. Dean, and their courses are now elected also by undergraduates. The courses of Mr. Dean in surveying and mechanical drawing are elected as 'extras,' and do not count in the scale of marks. Prof. Eustis' three courses, namely, descriptive geometry, differential and integral calculus and mechanics were all elected by undergraduates."

Prof. Gibbs (chemistry) reports:

"I had but three students, one senior, who took the elective; one from the engineering department of the Lawrence Scientific School, and one post graduate. Of these, only the senior, went through the whole term. The post graduate (!) was taken very sick, and went abroad. The engineering student (!) gave up when the difficult mathematics came in view, saying, he had not time. I believe I may claim to have had some influence in cultivating a scientific spirit among the young men generally; but, of course, such work—if work it can be called—is of a very intangible character. In my laboratory I devoted myself to work on new series of complex inorganic acids, which are destined, I believe, to play a very important part in the chemistry of the future. I have on hand a great mass of unpublished manuscripts, not quite ready for the press.

Whether or not these "new series of complex inorganic acids" did play the "very important part in the chemistry of the future" to which Prof. Gibbs thought they were destined, we do not know; but we think we do know that the kind of professor of chemistry which Mr. Lawrence desired to have supported on his foundation was one who was instructing rising young men in the chemistry of the present, rather than one who was instructing himself in the chemistry of the future.

The next report, for 1882, is a very singular and, we feel obliged to add, a thoroughly discreditable document. It caps the climax of this (to us) painful record. The comparative failure of the school was by that time patent. The growing and conspicuous success of the Sheffield Scientific School at Yale (due chiefly to the devoted labors of one man, Prof. Gilman, who put his heart and his brains into the work, and was ever ready to spend and be spent in its behalf) was by that time equally patent. One would have thought that, out of respect to Mr. Lawrence's memory, if nothing else, an honest effort might have been made now, if not before (it having been proved by others that a scientific school could succeed), to discover and correct the defects which had so far obstructed the growth of the school, and thus to fulfill the honorable obligation into which the college entered when it accepted Mr. Lawrence's first gift. Not a bit of it. The report is merely a labored and (not to put too fine a point upon it) silly effort to whitewash the past and present management of the school, and to make it appear that nothing is wrong but surrounding circumstances. It opens with a labored comparison with Sheffield, the curriculum of which is (most inaccurately) declared to be "much like that of Lawrence," with the slight exception that it has 15 professors and 9 instructors to teach it. Their course, in fact, is inferior to that at Harvard in that (1) "Botany and zoology are not taught" at Sheffield (terrible loss!), and (2) geology is taught in the first term of the senior year only, and chemistry in the first term of the junior year only; in other words, these studies were taught as they should be, as adjuncts and aids to the main purpose of the school, and not as standing upon an equal footing with the vast field of engineering. Moreover (3), the whole number of electives at Sheffield is only 19, whereas at Harvard the aspiring student has 114 to choose from! Nevertheless, the graduating class at Sheffield is "always small, sometimes not over 4, never exceeding 10 or 12," and we have this amazing attempt at an explanation why the classes of the Lawrence Scientific School always had been, were now, and ever must be small. Considering all the circumstances, educational literature will be searched in vain (we hope) for a parallel to its fatuous and willful blindness. We slightly condense the original:

This school was the first of its kind in this country, except the Rensselaer Polytechnical (sic) School, which is strictly technical. Its success has led to other similar schools, attached or separate, and they have divided the students. The demand for civil engineers for the working of mines is less than formerly. The measuring with chain, compass and level for locating a railroad, and the calculation of cuts and embankments require but a moderate amount of scientific instruction, not more than that usually possessed by contractors. The construction of bridges and roofs is in the hands of a few large companies, who build for a great many railroads, and who each require but a single engineer. The same is true of hydraulic engineering, for the management of water power for large factories or for the supply of towns. Instead of speculating upon the effect of these and other causes, the committee think more light can be obtained by a comparison with the School of Mines of Columbia College, which—"

But our article is already too long, and the comparison with Columbia, one of the latest of some dozens of successful engineering schools which had been started since the Lawrence began to decline and were then in full blast, is of a piece with the comparison with Sheffield already outlined.

A recommendation is then made and argued, which was soon after acted upon, for the practical discontinuance of the school as a separate organization and its merger in the college proper. The reason is clear in the preceding and following quotation:

In 1885-6 the whole number of students registered is 22, of whom 7 are regular students in natural history, 2 in chemistry, and 1 in engineering. The remaining 12 are special students.

The following table shows the number and class of students who took the three courses of this school which are not reported by the Dean of Harvard College:

	Hours per week.	
1st year, surveying, Mr. Knapp.	.6	{ 3 jr. 3 soph. 1 fr. { 3 sci. 1 gr.
2d year, surveying, Prof. Chaplin.	.6	1 sr. 3 jr. 1 sci.
Mechanics, Prof. Chaplin.	.3	1 sr. 1 jr. 1 sci.

This marks the lowest point of the school. Since then it has begun to go up in attendance at least. As Table IX. shows, there are a good many special students, and there are some signs of an attempt to approximate at last to the lines originally laid down by Mr. Lawrence in founding the school, which (we note again) the corporation is under a solemn and continuing obligation to adhere to. If Harvard really wanted to make a successful school adhering exactly to those lines, Harvard could do it, beyond doubt. It is an immensely strong and powerful university, with a prestige which is as a tower of strength to any rationally organized department which it earnestly supports. The trouble, as we see it, lies with the continuing lack of such support and of a suitable organization, rather than in any lack of faithful and earnest efforts of those immediately in charge of the school. Since 1885, at least, when Prof. W. S. Chaplin was appointed Dean and Professor of Engineering, there has been no such lack. Both under his administration and under that of the present Dean, Prof. N. S. Shuler, Professor of Geology (no professor of engineering has been appointed since Prof. Chaplin resigned in 1891), we fully believe that no abler nor more faithful efforts to advance the fortunes of a school of engineering have anywhere been made. The scope of this article has required it to deal only with organization and results. Otherwise it would have been a duty, as it would certainly have been a pleasure, to have recorded more fully these faithful efforts of individuals. As it is, we only add this note, to prevent unjust misconceptions.

PAPERS AT THE SAN FRANCISCO MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The list of papers read at the spring meeting of the Mechanical Engineers at San Francisco shows a very fair output as regards both quantity and quality. We reprint elsewhere in this issue two important papers on locomotive testing, one being the first report from the committee on a standard method of testing locomotives, the other a description of the experimental locomotive just set up at Purdue University. We also give elsewhere the substance of a paper reporting a new aluminum alloy, another describing several types of power meters, and a third on a new material for oilless bearings, "fiber-graphite."

Of the 19 papers presented at the meeting, 6 relate to steam engineering, not including the papers on locomotive testing above referred to. The best of these papers, and one so good that we hope to find space to reprint it in an early issue, is a description by Mr. Francis M. Rites, of the Westinghouse Machine Co., of the steam distribution in the Westinghouse compound engine. It has become well recognized among engineers that a compound engine to work at best economy should be designed for its load. The Westinghouse engine, however, was designed to work economically under loads varying between wide limits. It is probably the only instance on record in which the indicator diagram was made before the engine. Having determined what the steam distribution ought to be to accomplish the desired result, the next step was to devise an engine which would effect that distribution. After several months of investigation the discovery was made of the peculiar value of a receiver between the cylinders of a predetermined volume, which should act as a clearance chamber for compression in the high-pressure cylinder. As an evidence of the remarkable flexibility of the engine as actually built, it is stated that the valve adjustment may be set so far from true that the shape of the indicator cards is considerably altered without materially affecting the economy of the engine.

Two-Cylinder vs. Multi-Cylinder Engines.

This paper is a record of a series of tests of a peculiar engine so arranged as to expand the steam through either two or three cylinders. It is the theory of the author, Mr. Geo. I. Rockwood, Chief Draftsman of the Wheelock Engine Co., of Worcester, Mass., that more than two cylinders are unnecessary to secure the highest theoretical economy in the use of steam. He claims that the receiver may be so constructed as to take the place of the intermediate cylinder or cylinders. The paper, however, confines itself to the results of the tests, with the description of the very peculiar engine on which they were made, and does not attempt to expound the author's opinions. Whatever conclusion may be reached as to the author's somewhat revolutionary

theory, the fact that from an engine developing 178 to 200 HP. he obtained a horsepower with only 12.67 to 13.06 lbs. of dry steam (142 lbs. pressure) indicates that he knows something about engine designing. The tests of this engine showed practically the same economy with the two cylinders working as with the three cylinders. It should not be understood, however, that the author claims the ordinary compound engine to be equal in economy to the triple expansion.

On Compounding Centrifugal and Load Governing by a Rotary Piston Valve.

Mr. Wm. S. Aldrich, of Baltimore, Md., a new member of the society, described in this paper his plan of governing steam engines by the use of a piston valve having both a rotating and a reciprocating motion, each variable by the governor. He purposes to use a compound governor, making the rotary movement of the valve dependent on the speed of the engine and its reciprocating movement vary with the external load, or vice versa. The paper enumerated the advantages to be gained by the adoption of this idea and the various methods by which it could be carried out in different types of engine; but it did not state whether engines had ever been built or operated which were governed upon the plan described.

Economy and Efficiency of the Steam Engine.

The paper with the above title, by Prof. Cecil H. Peabody, of the Massachusetts Institute of Technology, was the only mathematical paper on steam engineering. The paper opened with the excellent recommendation that steam engine efficiency be stated in British thermal units in dry steam consumed per horse power minute, from which the actual efficiency of the engine (or the fraction of the total heat imparted to the engine which is converted into mechanical work) can be directly computed as follows:

1 HP. minute=33,000 ft. lbs.

The mechanical equivalent of heat=778, hence 1 HP. minute corresponds to

33,000÷778=42.42 B. T. U.

Therefore, the actual efficiency of a steam engine= 42.42÷the number of B. T. U. consumed per HP. minute. Having this efficiency a comparison may be made with efficiency of a theoretically perfect engine—i. e., with an engine whose only heat loss is due to the exhaust, which efficiency is:

$$E = \frac{T - T'}{T}$$

In which T and T' are the absolute temperatures corresponding to the boiler pressure and the back pressure.

As an example of this method, the author instanced a test of the experimental engine at the Mass. Inst. of Tech. laboratory, which showed a consumption of 231.7 B. T. U. per HP. minute,

42.42÷231.7=0.183,

a remarkably high result. Instituting in the formula above the temperatures corresponding to the pressures observed:

$$\frac{822.9-618.4}{822.9} = 0.2485$$

Then comparing the actual efficiency of the engine with this efficiency of a perfect engine, it appears that the engine, during the test quoted, was doing:

$$\frac{0.183}{0.2485} = 0.736$$

of the work that it was possible to do under the circumstances.

A Novel Fly-Wheel.

Mr. Chas. H. Manning, Superintendent of the Amoskeag Mills at Manchester, N. H., described the wooden rim fly-wheel which has recently been built to take the place of the cast iron wheel which failed with fatal results last October. We briefly described this new wheel in our issue of April 28. In correction of that description it should be said that the wheel's rim is made up of 8 courses of 4-in. plank, 7 of 2-in., and 29 of 3-in., each of which was reduced about ½-in. in dressing. The holes for the lag bolts were bored and the lag bolts were screwed in by a power-driven flexible shaft, enabling the work to be done very rapidly. The cost of this wheel, which is 30 ft. diameter and 9 ft. face, was but $7,000, or less than the cost of the cast iron wheel which it replaced. The designer computes its strength to be 10.58 times that of a cast iron one, hence it can run at a speed $\sqrt{10.58}$ =3.25 times greater than a cast iron wheel with equal safety. It is interesting to note that the failure of the old wheel was due to hidden flaws in the rim and ends of the arms. Specimens of the metal tested for tensile strength showed from 15,000 lbs. per sq. in. in sound pieces to not over 1,000 lbs. in spongy ones.

Some Tests of a Portable Boiler.

Mr. Wm. O. Webber, Superintendent of the Erie, Pa., Iron Works, described in this paper some tests of a portable boiler of 25 to 40 HP. The boiler was of the return tubular type, with a furnace placed under the upper portion and having its sides lined with firebrick. Thus the upper part of the boiler forms the crown sheet of the furnace and is a crown sheet which will never be left bare by falling water. The 25-HP. boiler evaporated 8.75 lbs. of water from and at 212° per lb. of combustible when working with natural draft, and 8.53 lbs. when working with forced draft. The 40-HP. boiler evaporated 9.87 to 10.5 lbs. from and at 212° per lb. of combustible.

"The Density of Water at Different Temperatures."

Mr. A. F. Nagle, of Chicago, discussed in this paper the discrepancy between different authorities concerning the weight of water at different temperatures. He concluded from his investigation that the figures of D. K. Clark are the most reliable, viz.: 1 cu. ft. at 39.1° F. weighs 62.425 lbs.; at 212° it weighs 59.640 lbs. To obtain correct intermediate points the author plotted the results in Clark's table and found that a broken, irregular line was obtained; he, therefore, concluded that there were errors in Clark's table, and drawing a regular curve he prepared a new set of intermediate figures based on this curve. His figure for the weight of water per cu. ft. at 62° F. is 62.35959 lbs.

The Electric Railway as Applied to Steam Roads.

Mr. B. J. Dashiell, Jr., described in this paper the experiments in high speed railway work made by the Electro-Automatic Transit Co. at Laurel, Md., in 1889. A circular track two miles in length was built, and a 2½-ton car was driven by electricity upon it at a speed as high as 118 miles per hour. These experiments were described and illustrated in our issue of Sept. 14, 1889. The track was of very light construction, 16-lb. rails being used, and the author states that this was the reason why high speed could not be maintained for any length of time. One derailment occurred when the car was running at 115 miles per hour. The car went off on a tangent and stopped about 1,000 ft. from the place of derailment. From these experiments and some following ones with a whirling machine, the conclusion was drawn that air resistance increased directly with the speed instead of as the square, a conclusion which is at best dubious, and which must be supported by much further evidence before it will be generally accepted. The results of these experiments were fully described and exhaustively criticised in Vols. XXIII. and XXIV. of Engineering News, pp. 506, 516, 530 of the former and pp. 5, 14, 37, and 283 of the latter.

Continuing, Mr. Dashiell described the 100-HP. electric locomotive recently built by the Thomson-Houston Co. for the Whitinsville (Mass.) Machine Co. to haul freight cars from the main line of the railway to the company's works, a distance of 1½ miles. The locomotive has four 42-in. drivers and weighs 42,525 lbs. The wheel base is 6 ft. 4 ins. The motor used weighs about 5,400 lbs. The speed reduction between armature and axle is 25 to 1. Current is furnished to the motor from an overhead wire as in ordinary street railway construction. The gearing of the locomotive consists of aluminum bronze pinions meshing with Mitis iron spur wheels. The locomotive can haul 6 to 12 loaded cars on a level at a speed of 5 miles per hour.

The remaining papers presented at the San Francisco meeting we shall abstract next week, together with the report of the proceedings.

ELECTRIC RAILWAY ON THE CONDUIT SYSTEM AT BUDAPEST.

In our issue of Jan. 31, 1891, we gave a brief description, with illustration, of an electric railway at Budapest, Hungary, on the conduit system, and as the successful operation of such a system is of great importance in view of the introduction of electric railways on city streets, we give the following abstract of an article in the New York "Electrical World:"

While in America the trolley system has been perfected and is being introduced on a large scale, in Europe experiments have been going on to perfect systems which overcome the objections made to the trolley wires in the hearts of large cities. Among these European roads there is one in the city of Budapest, which has apparently been quite successful, although so far it has been introduced in only one city: It is an underground conduit road, with an open-slotted conduit resembling that of cable lines. As the builders, Messrs. Siemens & Halske, of Berlin, have established a branch house in this country, it is not unlikely that a similar one will before long be introduced here.

There are at present four lines running in that city, the first of which was started July 30, 1889, and the last of which was completed about a year ago; portions of it have therefore been running almost three years. The total length of track is 12 miles, and the larger part of the road has double tracks. The sharpest curve has a radius of 82 ft., and the maximum grade is 1.6 per cent. The maximum speed allowable is 9.3 miles per hour, although 11 miles is allowed in some places; 6.2 miles is the limit in the densely crowded streets, while on crossings only 3.72 miles per hour is allowed. The cars are 20 ft. 4 ins. long and 6 ft. 6 ins. wide; the weight including one 16-HP. motor, is 4.8 tons without passengers. The gearing is by means of chains. There are 53 motor cars and 8 trailers in use. Starting rheostats are secured under the floor of the car. The connections at starting are made by means of a contact cylinder capable of being moved from either of the two platforms for each direction. The motor has separate pairs of brushes, which are thrown on or off by the regulating device.

The contact rails in the conduit are made of angle irons, one for each polarity. The contact with the car is made by means of a sliding device connected directly with the car and dragged along with it. It consists of two cast iron parts similar in shape to the shuttles in weavers' looms, which are connected by means of flat springs to a wooden frame. This frame passes up through the slot, which is 1.3 ins. wide, and is fastened on the bottom of the car between the front and hind wheels, the slot being in the track itself, as shown in our former illustration. In these frames are secured two well insulated copper cables which pass up to the binding post on the car. Of the stoppages that have occurred the majority have been due to the breaking of these frames; this seems to have been the weakest point in the system, but it does not seem that there would be any very great difficulty in designing these so that they will not be so frail.

The central station is situated in the middle of the system. A pair of feeder wires leads to each of the four lines; these are also under ground and consist of Siemens cables lead covered and armored with a steel band. It appears, however, that they are not quite ample, for on Sundays, when the traffic at some hours is very great, these cables are said to become so hot that they cannot be touched.

The boiler house contains five boilers, each with 1,055 sq. ft. heating surface, equipped with smoke consuming devices. The machine room contains three 100-HP. compound condensing steam engines making 180 revolutions, driving three dynamos by means of ropes. The voltage used on the system is 300. There are furthermore three 300-HP. compound engines driving dynamos at 130 revolutions by direct coupling.

The dynamos are shunt-wound and connected in parallel to common wires, which are connected through the switchboard to the four sets of feeders, the switchboard containing all the necessary apparatus, including an automatic interrupter in each line to protect it from the effects of short circuits. Each has a ground indicator in the form of lamps which, even in the driest weather, are more or less bright. It is stated, however, that the leakage is only a few amperes. During rainy weather, but especially when the snow melts, in which case the drainage of the conduit is not quite adequate, the loss by leakage is said to be quite appreciable. It was only during the winter before last that interruption was caused by this.

The switches on the track are operated by hand. At these places as well as on crossings with another electric road, the angle irons are cut, being electrically connected with each other by bent cables. As the illumination in the car, with the exception of a single oil lamp, is by means of incandescent lamps, the light goes out for a moment at each of these crossings.

The daily papers have recorded a few interruptions. Chief among these are short circuits in the traveling sliding contacts. Such interruptions, however, last only for a very short time. The injured contact frames are removed through the covered openings left for that purpose next to the track, and the car is then pushed by the one following.

The cost of the line is given quite differently by different parties. In one case it was stated to have

been about $47,000 to $55,000 per mile, including the central station. It is estimated by one authority that the cost of the road alone is about $37,000 a mile. We believe the makers give the cost at about $35,000 per mile.

It should be noted here that the system of street cleaning in Budapest is very good, which is an important point for such a road.

A NEW TYPE OF DAM.

At a recent meeting of the Engineers' Club of Cincinnati, Col. Latham Anderson read a paper on "A Proposed New Type of Dam." He was a member of a commission of engineers appointed by the Arrowhead Reservoir Co. to prepare plans for a system of irrigation for that company, for supplying the territory north and west of San Bernardino, Cal. The water for this purpose is to be obtained from the head waters of the Mojave River. In a particular basin in the mountains at this place there are four consecutive branches of the river having admirable sites for dams and reservoirs, all of which will be used, but the largest and the one which will be used first is known as the Little Bear Valley. The substance of the paper, somewhat condensed, is as follows:

On account of the configuration of the valleys very short dams will be required, extending between the steep rock slopes of the canyon on either side. The granite of which these slopes are composed forms excellent material for masonry, but the soil in the neighborhood does not afford material suitable for puddle, and on account of the frequency of earthquakes in this part of the continent it was considered unsafe to rely on a purely masonry dam. To meet all the conditions the following type of dam has been proposed by Col. Anderson: The water face of the dam to have a face of masonry on a slope of ½ to 1 of a uniform thickness, to act as a retaining wall when the reservoir is empty. The thickness calculated for a dam 150 ft. high is 10 ft. This masonry is to have a dry backing 2 ft. thick, with the joints well filled with cement mortar three or four inches from the lower face. A tile underdrain is extended along the bottom of this wall with outlets under and across the dam, and discharging below its foot at regular intervals of height. The dry wall thus acts as a drain to the masonry above it. This dry wall rests upon an earthen dam. Instead of being spread in layers in either of the usual methods, the earth, granite boulders and gravel are piped into place by the hydraulic method. The wall is first carried up as high as it can be safely built on this slope without support. When a section of the wall is finished to this height the earth backing is filled in to within a few inches of the top of the wall. Another section of the wall is then built and another layer of earth filling piped in; this process being carried on to as high a level as it is practicable to pipe in the earth. It is expected to be possible to construct the dam in this manner to a height of 125 or 150 ft., above which level the earth filling will be made of the same material as below, but in one of the usual manners, probably with wire rope and trolleys. The lower slope will be kept in shape by dry stone facing, carried up as the piping proceeds.

With water convenient, under a good working head, the earth can be filled in at from 4 to 5 cts per cu. yd. The upper portion to be filled in by cable will probably cost from 20 to 25 cts.

The wall is to be of concrete filled in with large blocks of granite, the joints in no case being less than 2 ins. thick. The facing, 10 ft. thick, is to be of large blocks of granite rubble laid in cement mortar with ¾-in. joints. The material, including blocks of granite weighing four to five tons each, is to be distributed on the wall by wire rope and trolley. The canyon has bare rock walls so nearly vertical that the dam is only 50 ft. long on the bottom and less than 200 ft. at the height of 125 ft. The thickness of the dam on the bottom is over 90 ft. It has a slightly arched form in plan. Its total height is to be 150 ft. The upper 25 ft. traverses a long granite ridge after leaving the canyon.

PARTICULARS IN WHICH MUNICIPAL OFFICERS SHOULD PROTECT THE MUNICIPAL CORPORATION IN GRANTING WATER-WORKS FRANCHISES TO PRIVATE COMPANIES.(a)

The fact that considerably more than one-half the water-works plants in this country are owned and operated by private companies is sufficient excuse for the title of this paper, but a somewhat extensive professional examination of franchises of this character has satisfied the writer that very few of them contain such provisions as fully protect the rights of either the grantor or grantee.

As a matter of common knowledge, it may be assumed that it is the expectation of both the municipality and the company that the city or town will ultimately become the owner of the water-works property and, sooner or later, in almost every instance, this expectation is realized. Such being the fact, it requires no argument to prove that the franchise granted should assure the construction of such a plant as the municipality can afford to purchase, or, in other words, such a one as shall fully supply its needs and minister to its growth and prosperity.

As a general proposition, I therefore assume, that in preparing to grant a franchise to a private company, the preliminary action of the municipal officials should be exactly similar to what it would be in case the works were to be constructed and operated by the municipality. The usual and proper action in the latter case would be to secure the services of a competent hydraulic engineer to make a thorough examination of the whole subject, and to prepare a detailed report as to the quantity and quality of water required, the best source of supply, the best plan for obtaining the same, the head under which it should be delivered to private consumers and to the municipality for the suppression of fires, the size, character and quality of the mains to be employed and the required performance of the pumping machinery, if such is to be used.

With this detailed information in the hands of the officials, they are prepared to advertise for proffers and to grant a franchise, which will require and insure the construction of such works as will fully meet the requirements of the municipality, and one which it can afford to purchase at any time and pay a reasonable price therefor.

The following important detailed provisions should be embraced in the contract constituting the franchise:

1. The minimum quantity of water which the source of supply shall be capable of furnishing in a dry season, or a succession of them. This determination with reference to any proposed source, to be made by the consulting engineer of the municipal corporation. The importance of such a provision is obvious, as the daily minimum supply which can be obtained should be sufficient for the needs of the municipality for a period of at least 20 years. Any failure in quantity might result in serious loss to the town in case of a purchase of the works from the company, coupled with a subsequent discovery that the supply was inadequate for the increasing population. It is, perhaps, unnecessary to add that, in the opinion of the writer, the required quantity should not be less than 100 gallons per capita per day for the estimated population at the expiration of 20 years.

2. The methods by which the quality of the water should be determined should be definitely stated, together with the general characteristics required. Of course, the determination depends upon the results of chemical analysis and bacteriological examination and also upon a critical and intelligent personal study of the contributory watershed, to settle questions of possible future contamination.

3. The right should be reserved to the town officials, under the advice of the consulting engineer, to determine the size and character of the conduit which is to conduct the water from the source to the town or city.

This detail assumes the more importance from the fact that in many cases it becomes desirable that, for the purposes of increased pressure at fires, the plant should be temporarily converted into a direct pressure system, by shutting out all connection with the stand-pipes or reservoirs, in which case the conduit is required to convey water not only at the rate of the average consumption but also, in addition, at the rate at which water may be used for suppression of the conflagration. This fact has an important bearing upon the determination of the required capacity of the conduit.

4. In case pumping is required, general specifications should be inserted, which shall determine the general character of the engine and boiler house and chimney, the character and capacity of the boilers, the general characteristics, capacity and duty of the pumping engines and their adaptability to perform the particular service required.

5. The capacity and character of the stand-pipe or reservoir should also be settled, leaving the final determination as to the sufficiency and adaptability of the several details of site and construction to the judgment of the consulting engineer.

6. The franchise should reserve the right to the municipal officials to determine under proper conditions and under the advice of their engineer, the character of and the particular location of the pipe mains in each street or place, the depth at which they shall be laid below the established grade of the streets and the numbers, location and style of the gates, fire hydrants and other fixtures to be connected therewith.

In connection with this clause should be inserted a detailed specification of the material forming the pipe, its method of construction and the details for laying the same.

7. The determination of the sizes of the several mains should be reserved to the municipal officials acting under the advice of a competent engineer, who should be required to carefully adjust the same to the probable economical uses and requirements of the same for present use and future extension.

8. The material and workmanship constituting the service pipe laid in the streets, and the manner of filling the trenches and restoring the improvements over the same, should be carefully detailed in the contract constituting the franchise. The requirements in relation to restoring improvements when interfered with at any stage of the work should be detailed and the town protected from any accident to person or property resulting from work done by the company, or from its interference with the streets.

9. Provision should also be made for maintaining the integrity of all existing subterranean conduits of whatever name or character, whether the property of the municipality or otherwise.

10. The contract should definitely state the terms and conditions on which future extension or enlargement of the works shall be made.

11. It should define the tests which are to be successfully made, as a condition precedent to the acceptance of the completed work, as in practical conformity with the terms of the contract on the part of the company, and before any sums of money are paid under the contract.

These tests should consist of an internal pressure of at least 100 lbs. per sq. in., applied to the pipe distribution and fixtures for a period of at least one hour continuously, without causing leakage of water or rupture of any of the parts. The test of capacity to suppress fires should be equal to or exceed the severest test which is likely to occur in the practical operation of the works, even under unusual and unexpected conditions. The duty test of the engines should be a continuous one of not less than two days in duration, conducted under the direction of a hydraulic engineer employed by the municipality.

12. The franchise should contain a detailed schedule of the maximum rates which may be charged to private consumers of water during the life of the agreement.

13. The limit or life of the franchise should be definitely settled, and should not probably exceed 10 years as a maximum. Provision should also be made for extension of the time limits of the franchise, at the end of prescribed term, if desired by both parties. I am also inclined to the opinion that the franchise thus granted should, as near as possible, be an exclusive one for the determined period.

14. It should be definitely understood, agreed and stated, that in case the municipality shall elect to purchase the plant at the termination of the time limit of the franchise, that it shall not be held liable to pay anything for the franchise itself, or good will of the business.

It seems to the writer, that in the nature of things, the municipality does not and cannot sell or permanently alienate the franchise itself. It is an inalienable function of the government, and the municipality can only lease, for a valuable consideration, the right to temporarily exercise the rights and privileges of the owner, and at the termination of the grant or lease, the municipal corporation resumes the active exercise of this function, which had been temporarily intrusted to an agent.

It logically follows, of course, that in accepting a franchise under such conditions the grantee shall receive such terms of compensation as shall render his enterprise reasonably and beyond peradventure remunerative, in case the grantor shall elect not to extend the franchise beyond the first named time limit.

15. The franchise should also contain a provision which should detail the methods which shall be employed to determine the sum of money to be paid for the plant by the municipality, in case it shall elect to purchase the same at the expiration of the time limit, and the several items of the property should be enumerated, which are to enter into the account, and on which values shall be placed, but as before indicated, the value of the franchise or any supposed increase in its value should be rigidly excluded, because the franchise itself has never ceased to be property of the public.

16. Finally and generally, the franchise should contain such comprehensive, as well as detailed provisions, as shall insure the designing and construction of such a system of works as shall be thoroughly well adapted to the present and prospective uses and needs of the public, and also assure their management and administration on economic principles and along business lines. It seems to the writer that any water-works plant constructed and operated under the provisions of a franchise such as is hereinbefore indicated, would have the following manifest advantages over the many plants carelessly designed and constructed in the past, and

(a) A paper by Mr. J. Nelson Tubbs, C. E., read before the American Water-Works Association, May 17, 1892.

operated by companies viciously organized and loosely or dishonestly administered.

(a) A system of works thus designed, constructed and operated, would thoroughly meet the wants of the municipality and would command its confidence, and it would thus have no hesitation in purchasing the plant at a fair valuation, being assured of its permanent substantial value.

(b) Such a system would furnish abundant safety to investors in its securities, and make them "glit-edged" in the market.

(c) It would, in case proceedings were instituted by the municipality to purchase the plant, eliminate all those usually perplexing questions of alleged imperfect design and construction, which are ordinarily relied upon to depreciate the market value of the water-works property.

(d) Such a franchise would furnish a ready standard to which could be referred for settlement all questions or differences involving the relative rights, duties and responsibilities of the company on the one hand, and the individual and the municipality on the other.

(e) An examination of the provisions of such a franchise would render it a comparatively easy matter to determine upon such a compensation for public use of water, which, with the probable receipts from private consumption, would render the investment a safe and remunerative one for the company, and at the same time not oppressive upon the municipality, considering the benefits received.

This paper is not written for the purpose of creating a prejudice against, or to excite antagonism towards, private water-works companies. Their mission has been, in many instances, a useful and beneficent one, inasmuch as by their efforts it has been rendered possible for many financially weak municipalities to enjoy the protection to health, life and property which an abundant supply of pure and wholesome water always insures. By the enterprise of these companies, the ignorant have been educated, the prejudiced have been enlightened, the sluggards vitalized and the blessings of pure water brought into the daily living of untold thousands many years in advance of a natural public awakening on the subject. The intention of the writer of the foregoing has been rather to indicate, in some detail, a method by which it seems to him, the best interests of both the private company and the municipality may be conserved, and the whole business relieved to a large extent of its purely speculative features, and relegated to the domain of legitimate business enterprise.

PROTECTION OF EXPOSED WATER MAINS CROSSING BRIDGES. (a)

I think it will be generally conceded that frozen mains and services are one of the most annoying accompaniments of the winter months in our northern latitudes. Adequate fire protection demands that a frozen main be put in order at once and at any expense.

The distribution system of mains in most all water works require that some, or many courses, or rivers, be crossed, either underneath the bed or over bridges. Many under crossings are difficult of original construction, and sometimes uncertain as to permanency, while an overhead bridge crossing is always accessible if leaky, the defects are apparent at once, and are only liable to the one objection of freezing.

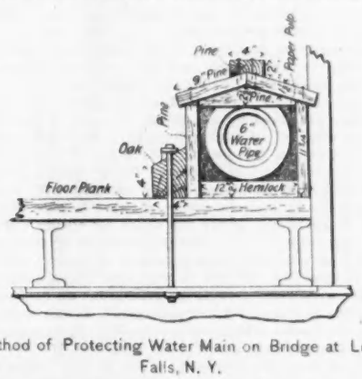
In designing the Little Falls (N. Y.) Water-Works system I found it necessary to make four crosaings, three over water courses (the largest one, the Mohawk River, and one overhead railway crossing. In all these cases an under crossing was entirely impracticable.

Desiring to use the best and most serviceable non conducting material. I examined various works in which the subject of non-conducting materials is mentioned. I found that all the tests are based upon the radiation of heat from steam pipes, and not a single author gives any data upon natural temperatures in cold pipes. Steam means a vapor of water heated up to a normal or sendible temperature of 212°, or the boiling point, and a surplus of about 966° of latent heat, which freeing itself produces the desired heat or warmth through radiation from the pipes containing or transmitting the steam. This condition is entirely different from the case of a water main. Water in a main in winter is at about the temperature of 50° F. while the freezing point is 32°. The water may be kept fluid as long as the temperature in the main does not fall below 36° or 38°. The temperature of steam being so high, all non-conducting materials used in connection with it must possess, in addition to the qualification of non-conducting properties, also an element of non-combustibility—while the non-combustible properties cut no figure with water main. I found that Haswell, in the well known "Engineers and Mechanics' Pocket Book," gives the relative non-conductibility of materials, based upon hair felt at 100. as follows:

Hair felt, 100; mineral wood No. 1, 83.2; sawdust, 68; mineral wood No. 2, 67.5; charcoal, 63.2; pine wood, 63.2; loam, 55; line, slacked, 48; asbestos, 36.3; coal ashes, 34.5; air space, 2 in., 13.6.

In Vol. V. and VI. of the Proceedings of the American Society of Mechanical Engineers will be found a very elaborate paper on the subject of non-conducting coverings for steam pipes, prepared by Prof. John M. Ordway, Boston, Mass. He arranges the various materials in order of efficiency as follows—Fahrenheit units, 1 sq. ft. in one hour: Glazed cotton wadding, 47.6; wool wadding, 81; slag wool and straw board, 90.51; live geese feathers, 96.4; hair felt, 102.3; calcined magnesia, loose, 123.6; cork charcoal, 126.5; pine charcoal, 136.6; washed fossil meal, loose, 145.1; plaster of paris, 309.4; extremely fine sand, 317.5; air space, 479.9; fibrous asbestos, 489.9; coarse sand, 620.7; fine sand, 623; naked pipe, 1,555.10.

In the course of the discussion over Prof. Ordway's paper, Mr. E. E. Leavitt, Jr., then president of the society, stated that when he became connected with the Calumet & Hecla mines in 1874 it was then the custom in carrying steam pipes underground to excavate a trench, place the pipe and then shovel the dirt back; the condensation was enormous; the defect was remedied by applying a coating of plaster of paris and sawdust, mixed in the proportions of one part of plaster of paris to two parts of sawdust. The plaster and sawdust was mixed as you would ordinary mortar and put on 2½ ins. thick. While the covering was wet the condensation was heavy, but when it once became dry the condensation was less than 1% of the former loss, being about 5% total loss by condensation. The idea was obtained from a boiler covering used at a fair of the Franklin Institute in 1865. Prof. Eggleston, School of Mines, Columbia College, also mentioned



Method of Protecting Water Main on Bridge at Little Falls, N. Y.

the fact about the bridge of Grenoble which was built in the year 1626, and was destroyed by fire in 1837 (an interval of 211 years), that all the iron surrounded by mortar was found to be intact and just as bright when taken out as it was when the bridge was built. On the contrary, that which was not so surrounded or where there was an air space was very much rusted.

These two facts struck me very forcibly as to a possibility of combining both, with a view of protecting water pipes from loss due to radiation of heat and oxidation, or rust. I at once conceived the idea that it was practical to whitewash over with Portland cement a water main laid in a trench, then cover it with 3 to 4 ins. of plaster of paris and sawdust, apply an outside thin coating of cement mortar, producing a covering, when dry, that would be a preservative to the iron, a good non-conductor of heat, and, what is very desirable, at a reasonable cost. This scheme did not strike me very favorably in cases where the pipe is entirely exposed, a bridge crossing for instance.

The best non-conductors make a loss in any event, some more and some less. Prof. Ordway's testsshow that cotton and wool wadding make the least loss, while an air space pure and simple, or asbestos, rank very low, not much better than sand. Asbestos is a mineral fibrous substance which when separated bears a close resemblance to cotton, or perhaps more nearly to silk fibre. Trace it back and we find it is simply aluminum or clay, but in a different form, and while possessing the property of being non-combustible, probably owes all its non-conducting properties to the confined air held between the fibres. The province of asbestos is simply to protect the more combustible materials, which are the real non-conductors, from being charred or destroyed. Prof. Ordway, in his paper, remarks in regard to asbestos:

"Asbestos is commonly supposed to have wonderful virtue in resisting heat, but there is really no magic power in the mineral fibre. It is a non-conductor only when it is in a light, downy condition and full of air. It was observed that in those cases in which asbestos paper is put between the pipe and hair felt, the asbestos fails to prevent the scorching of the hair. Incombustibility should not be confounded with non-conducting power. And then again, experiments Nos. 47 and 50 show that a wrapping of asbestos paper does not insulate so well as the same thickness of mere air. The popular confidence in asbestos partakes of the character of a superstition."

An air space pure and simple ranks low, due to mobility. Prof. Ordway says:

"Air alone, as is shown by experiment No. 50 in the tables, transfers much heat when it can move about in a closed space. The usefulness of mere air spaces has been much overestimated, for they can rarely be placed so as to render much service. The air no doubt slides much more freely over smooth particles. It is not unlikely that the great difference between wool and asbestos is largely due to the smoothness of the scapy mineral fiber asbestos. It is hard to conceive of anything better fitted to counteract the mobility of air than the irregular twists of flattened cotton fiber, the crinkles and scaliness of wool, the fringed edges of down filaments, or the feathered angles of snow-like crystals. When more and more organic fiber is crowded into a given space, the thickness of the stratum remaining the same, the transmissive power appears to be diminished till a certain limit is reached beyond which there comes an increase. Probably, then the mobility of the air has been brought to a minimum, and the proper conducting power of the fiber begins to act more decidedly."

The Prof. Ordway experiments show that we must look in the direction of cotton and wool fiber for the best non-conductors, but with water pipes it has seemed to me that we must go a step further. We must find some substance or substances in combination that will supply back again the increment of heat lost. With steam, the boiler supplies this. A water main is constantly losing some heat from the water with the very best non-conductor pure and simple, and the only ordinary remedy is a more free circulation to bring new particles of the water into the exposed pipe to be acted upon. Where the circulation is rapid and constant through the whole 24 hours, this plan, in connection with a good non-conductor, fills the bill.

Unfortunately, however, during the hours of the night there is usually very little legitimate consumption, and resort must be had to waste pipes to maintain rapid circulation during the night hours. This means a loss of water, and as it cost money to produce the water in the mains, it is also a financial loss.

The question of spontaneous combustion then suggests itself. Water pipes in winter, or even at any time, are always at a low temperature, with a certain amount of moisture or sweat on the outside. Spontaneous combustion under these conditions will hardly, if ever, take place; in fact, it may be assumed never. Again, all chemical changes, even decay, which is a chemical change, produce heat, and I turned my enquiries in this direction. I found that at all the knitting mills there is a waste product called wool waste, being composed partly of wool and cotton fiber; that this waste, due to the process of manufacture, is partly saturated with oils, and when placed in a pile slowly generates heat and finally decays. The best grades are sold to the paper makers, and lowest grades thrown away. The best grades vary in price from 1 to 2 cts. per pound. This material, then, just fills the required conditions of being, first, the best class of non-conductor of itself, and also having in combination a partial saturation of oil, which promotes decay, hence heat. I determined to use this material as a filling around the water pipes crossing the bridges and as wood laid with the fibers parallel, and in no case with the ends of the wood at an angle with the pipe to prevent the mobility of air through the cells of the wood, is a very good non-conductor as well as a cheap outside covering. I determined to make a box surrounding the pipe of 1½ in. pine plank, so constructed as to be 6 ins. away from the pipe at any point. The top of the box I made roof-shaped with an outside top stringer of wood covering the joints of the roof boards on top. Where the side plank join together, I butted the ends and nailed an inside cleat or batten on to cover the air space. The pipe I rested on blocks of wood set about 4 ft. apart, filled in the space in the box with the wool waste, tightly rammed in, protecting the outside butts of the side and roof planks with strips of tin nailed close. (See accompanying cut.)

I also tapped in two 1½-in. wastes, one on each end of the bridge, to be used in case of an excessively cold spell of weather. The bridge coverings have now run about six years, and with perfect success. I used the wastes the first years, but for two seasons past the waste was not opened, and even where there was a very small consumption the water has run free until late this spring, when one of the pipes on a bridge gave out. On examination I found that decay had progressed so far with the wool waste as to render it valueless for the purposes intended. This has taught me the additional lesson that five years is about the lifetime of the effective working of the wool waste non-conductor in connection with water mains.

I have also had another experience with wool waste as a non-conductor and generator of heat protecting

(a) A paper by Mr. S. E. Babcock, Chief Engineer of the Little Falls, N. Y., Water-Works, read before the American Water-Works Association, May 18, 1892.

water pipes. In the Little Falls Water-Works system there are two series of pressure valves cutting down the pressure from 240 to 140 lbs. to the square inch. The valves are the Ross pressure valve, which are essentially a balanced valve or piston with three working disks, and regulated by a small pressure valve, ¾ in. in diameter. In very cold weather, if the ¾-in. pipe should freeze, or a thin film of ice form on the barrel of the valve, it would work badly. To prevent freezing, I placed the first valve set in a house and arranged for a fire during the winter. When it was found desirable, a second feed line was constructed from the distribution reservoir to town. This line was so located of necessity that it was impracticable, without a heavy expense, to place the valve in a house, but a well in the road was the best plan that could be adopted. As the bridges had then worked a year satisfactorily, I designed a well enclosing the pressure valve and determined to depend upon the wool waste covering the valves, in bulk, for protection, in lieu of a fire. This plan has worked satisfactorily to date. This valve has never frozen, and when the well has been opened in very cold weather the air inside has always been found warmer than the surrounding atmosphere. The wool waste I remove every spring, send it up to the distribution reservoir grounds and bring it back in the fall again, each year adding a little new waste. This scheme has been a perfect success. It is but fair to add that this well is connected to the sewer leading down the hill and it may be that a portion of the hot air comes from the sewer.

In conclusion, I fell safe in saying that for pipes laid under ground with a partial depth or protection of earth, the Calumet & Hecla mine plan of a protection of plaster of paris and sawdust, with the addition of a whitewash of cement on the pipe as also on the outside of the non-conductor is, in my judgment, the best and cheapest method of construction to provide against freezing, while for bridges or any above ground pipes, a wooden box filled with wool waste, which is partially saturated with oil, is by far the best protection of which I have any knowledge; it combines both the non-conduction and the slow generation of heat. I trust that my researches in this direction may be of service to other members of the American Water-Works Association.

RAILWAYS AND MINES IN THE ARGENTINE REPUBLIC.

From a recently published report by Mr. E. L. Baker, U. S. Consul at Buenos Ayres, we abstract the following remarks referring to the railway and mining interests for the year 1890:

While the crisis has greatly interfered with the building of projected railways and stopped work on most of those which are in process of construction, yet it appears from the report of the Board of National Railway Direction that there was no inconsiderable amount of track laying last year. At the end of 1889 the railways amounted to 5,030 miles; and at the end of 1890 to 5,737 miles, thus showing that during the year over 700 miles of new railway were opened to traffic. Six railway companies did not earn enough to pay running expenses. Notwithstanding the increase of 700 additional miles opened to traffic in 1890, there was a decrease of 934,380 in the number of passengers and of 1,222,600 tons in the amount of freight carried. There is no doubt that some of the railway lines are failures, built under a pressure and "boom" before there was a demand for them; yet it is equally true that the general stagnation of business and commercial depression have greatly interfered with the traffic even on the best paying roads.

Unfortunately, the Argentine Government, in its desire to assist railway building, has, in a number of cases, granted concessions for enterprises which it was notorious would not be able to do more than—if so much as—pay expenses; and it guaranteed to pay what was lacking from the receipts to make from 5 to 7 per cent annually upon the investments. It appears from the report already referred to that, by virtue of these guarantees, the national government has been systematically bled to the extent of millions of dollars. The sums which have thus within the last ten years been paid by the government in the shape of guarantees are about 25 per cent. of the original cost of the roads. The total amount required for this purpose annually is $4,624,473.93.

In regard to mines and mining, during the last year there has been no movement of any importance. In spite of all that has been written and proved in regard to the existence of coal in the Argentine Republic, no actual steam-producing "black diamonds" have yet reached this market. A fortune is in store for the man who shall be able to supply native merchantable coal to this country, with its thousands of miles of railway and its growing manufactures, all of which continue to be supplied with fuel from England and Wales, amounting now to more than 500,000 tons annually.

In regard to petroleum, I learn that the steam-producing qualities of that found in the neighborhood of Mendoza have been put to the test on some of the locomotives of the Buenos Ayres & Pacific Ry., but with no very encouraging result. In order to utilize it for such purpose, a peculiar construction of the furnaces is necessary, and meanwhile English coal will continue to be used. So far as illuminating purposes are concerned, it is very evident that, for the present at least, the supply of kerosene must continue to come from the United States.

Salt of a very superior quality is now regularly received at this port from the extensive salt works near Carmen de Patagones. The imports for 1890 were 850 tons, mostly of table salt; but it is probable that hereafter quite enough will be produced in the country to supply the demand without the necessity of depending on Cadiz for it.

DRAWING PAPER AND THE FAILURE OF WATER-COLORS.

The following summary of a paper recently read at the Chemical Society by Prof. W. N. Hartley, on "The Acid Action of Drawing-paper of Different Makes," was contributed to a contemporary by Mr. C. J. Woodward. The professor, after stating that he has shown that moisture and acidity are the chief causes of the fading of certain pigments, refers to experiments he has made with various kinds of paper in use, both of old and recent manufacture, and comes to the conclusion that such papers are invariably acid, even those of the most excellent quality. He finds that after steeping paper in dilute sulphuric acid subsequent washing will not entirely remove the acid from the linen fiber of which the best papers are made. The acid seems to combine with the fiber, and the resulting compound is only slowly decomposed or dissolved by the action of water. "Professor Church, in his valuable work on 'The Chemistry of Paint and Paintings,' remarks that he is unable to indorse my statement that the best drawing-papers have an acid reaction. He finds, in fact, that sized papers are generally neutral to test papers, and that inferior papers are often more slightly alkaline than acid. As some doubts may be entertained as to the quality of the papers examined by me, it may be well to state that they were all of the best quality. That no question may arise on this point, I have tested the samples named below in three ways: (1) by dropping litmus solution upon the paper, (2) by washing with a sable brush, (3) by steeping strips of paper in pure distilled warm water and testing the water for acidity and also for sulphates." After giving particulars of the papers and the acid reactions obtained, Professor Hartley goes on to say, "It will be seen from these notes that there were good grounds for attributing an acid action to even the best of drawing-papers." In the course of the discussion which followed, Mr. Wade suggested that the sulphate detected by Professor Hartley was derived from this sulphate, which it was well known was used as an antichlor for manufacturing paper; and Mr. Groves made inquiry as to the way in which the samples had been stored, suggesting that a possible source of the acid was gas used in the room where the packets are kept. Professor Hartley said, in reply, that as a rule the samples tested were taken from the middle sheets of sketch blocks, and he did not think the acidity could be traced to gas.—"Invention."

An electric railway, with Abt rack rails, is being built in Upper Savoy, Italy. The grades are from 16 to 35 per cent., and the curves from 115 to 165 ft. radius. The generating plant consists of three dynamos driven by turbines. Each car has two 33 HP. motors and two sets of gearing. The conductor consists of inverted T-rails, supported on iron posts and brackets.

The Chicago & Erie R. R. is to be equipped with block signals, and the contract for the necessary plant has already been let. Other improvements will be made to the track in view of the heavy traffic to Chicago next year.

Improved street railway tracks have been laid at Washington, D. C., in accordance with an order from the District Commissioners that all such tracks must be level with the surface of the streets. The extent of track changed and unchanged was as follows on April 25: Metropolitan Ry., 18 1-3 miles of track, with 16 miles of improved girder rail; Washington & Georgetown Ry., 15 1-3 miles, with improved rails throughout, except about 3,000 ft.; Columbia Ry. Co., 2.8 miles of track, all laid with girder rails, half being grooved; Capitol, North O St. & South Washington Ry., 13.3 miles, all laid with grooved girder rails; Anacostia Ry., 12.98 miles, with 12.35 miles of girder rails.

The British brake returns for Dec. 31, 1891, show that at last there is a decided movement to eliminate all the odds and ends of past brake practice, and settle down upon the automatic vacuum or automatic Westinghouse only, in the proportion of 2 to 1 in favor of the vacuum. In 1887 the two were nominally equal, together aggregating about 54 per cent. of the total stock, but there were then about as many straight vacuum as automatic vacuum brakes in use, and the apparent great gain means that the straight vacuum brakes have been converted into automatic. The chain brakes, of which there used to be 7,000 in use, are down to 875; "Fay's" brakes, of which there used to be over 2,000, are down to 200. The straight vacuums are rapidly decreasing, and there never has been but few straight Westinghouses. Though at present the vacuum type seems to be gaining on all others, it is doubtful if this will continue. In the end the greatest attainable efficiency will be demanded, even at increased cost.

A new form of locomotive for narrow gage railways and steam tramways has been built by M. Bollee, of Mans, France. It has a vertical boiler, placed between the axles to keep the center of gravity low, cylinders 9¾ ins. diameter, and a wheel base of 6 ft. 10 ins. The weight is 24,700 lbs. empty and 29,700 lbs. with coal and water. The smokestack has a spark arresting device, and a chamber for muffling the sound of the exhaust. The cab is at the front of the engine.

High water in the Mississippi River is causing considerable damage in the South, and some breaks have occurred in the levees.

The two-cylinder compound locomotive designed by Mr. C. H. Batchellor, Chief Draftsman of the Rhode Island Locomotive Works, Providence, R. I., has been awarded the Elliott Cresson medal by a committee of the Franklin Institute. The special feature of the engine is in the intercepting valve, invented and patented by Mr. Batchellor. Engines of this system have been described and illustrated in our issues of Dec. 27, 1890, and Jan. 3 and Dec. 12, 1891.

A grade indicator for locomotives is being tried on a French railway. It is said to consist of a horizontal tube, 13 to 16 ft. long, with a vertical tube at each end, one of them being in the cab. The tube is filled with water, and the engineman can see by the height of water on a graduated scale what is the grade of the road.

The Mexican & Central American Ry. Co., of London, England, has been incorporated for the consolidation and completion of several railways authorized by the Mexican government, for the connection of the northern and southern railway systems of the country. The line will run from Vera Cruz to the Tehuantepec National Ry. at Jaltipan, about 130 miles; about 45 miles from Vera Cruz are now in operation, and work is said to be in progress on the extension, which is to be completed by 1894. It will be a standard gage road with a third to accommodate through traffic from existing meter gage connections. The consulting engineers are Brunlees & Kerrow, of London.

The trainshed at the new terminal station for the Illinois Central R. R., at Chicago, illustrated in our issue of April 28, will have a central span of 80 ft., and two cantilever side spans of 30 ft. There will be six tracks. The contract has been let to the King Bridge Co., of Cleveland, O.

A proposition to build three steel observation towers in Chicago, one in each division of the city, has been made by Mr. C. H. Merrill, and the Council Committee on Buildings has reported favorably on the erection of one tower as an experiment, which will probably be located in Lincoln Park. The tower is to be 350 ft. high, 87 ft. and 40 ft. square at base and top, and the estimated cost is $150,000. An elevator will carry passengers for a charge of 25 cts.

The General Electric Co., which has been organized as a consolidation of the Thomson-Houston and Edison companies, has a capital stock of $50,000,000, and has elected officers as follows: Pres., C. A. Coffin; First Vice-Pres., Eugene Griffin; Second Vice-Pres., Samuel Jewell; Secy., E. J. Garfield; Treas. and Asst. Secy., A. S. Beves.

An important decision was rendered on May 12 by the Supreme Court of Illinois, at Ottawa, Ill., by which the City Council of Chicago is authorized to open 56th, 60th, 72d, 79th, 82d, 90th, and 95th Sts., across the tracks of the Illinois Central R. R. This decision was brought about by the railway company filing a bill in the Circuit Court enjoining the city from opening said streets, claiming that street crossings could be opened only by the city building viaducts or subways. The city then passed three separate ordinances for opening up these crossings, and as both the railway company and the city received their charters direct from the state, a legislative decision was necessary. This was rendered by Judge Tuley, and is abstracted as follows:

"The question here involved is not the adjustment of equities as to street crossings between the railway and the city, but it is whether or not this court has the right to interfere with and limit the city in the exercise of its lawful powers for the public benefit. The great weight of authority is that the railways must yield to the municipality, a government agency repre-

senting the public at large, and not that the public must yield to the railways. Entertaining these views, we find no equity in complainant's bill. It is therefore ordered that complainant's bill be dismissed for want of equity."

A similar decision was rendered in 1891 by the Supreme Court of Illinois against the Chicago & Northwestern Ry.

The gross earnings of railways in the United States for the month of April are not very favorable, according to figures collected by the "Financial Chronicle." The aggregate earnings of 150 railways, with a mileage of 99,914 miles, were $42,102,375, a gain of 3.68 per cent. over the earnings for the corresponding month of 1891. This is the smallest increase, except that for January, of any month of the present year.

pressed 4¾ ins.; span 3 elevated 2⅛ ins.; span 4 depressed ⅝ in. (3) Loading span 1 with four locomotives and span 3 with 14 locomotives—Span 2 elevated 1¼ ins.; span 3 depressed 2⅛ ins.; span 4 depressed 1⅝ ins. (4) Spans 2 and 4, each half loaded—Span 1 elevated ¼ in.; span 2 depressed 3½ ins.; span 3 elevated 2 ins.; span 4 depressed 3⅜ ins. (5) Loading span 4 with 14 locomotives—No effect on span 1; span 2 depressed ¾ in.; span 3 elevated 1 in.; span 4 depressed 2⅝ ins.

A recording marine compass is being manufactured by the Seth Thomas Clock Co., of Waterbury, Conn. From the somewhat vague newspaper reports it seems to be a combination of a chronometer and magnetic compass provided with the necessary mechanism by

ELEMENTS OF WEATHER IN THE UNITED STATES OF MOST INTEREST TO ENGINEERS FOR THE MONTH OF APRIL, 1892.

[Furnished to Engineering News by the Department of Agriculture.]

	Station.	Temperature. (Deg. Fahr.)				Wind.			Precipitation—(Rain and melted snow)—inches.		
						Velocity in miles per hour.		Direction at time of max. velocity.			
		Average	Max.	Min.	Range.	Average	Max.		Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	39.4	71	14	57	11.1	48	SW	0.44	0.16	6
	Portland, Me.	43.6	72	24	48	8.7	30	NW	1.04	0.33	5
	New York City	49.9	79	31	48	11.3	39	SW	2.36	1.00	7
	Pittsburg, Pa.	50.2	79	27	52	6.6	30	NW	2.93	1.18	15
	Chicago, Ill.	44.0	78	23	55	22.2	65	N	2.17	0.70	11
	Omaha, Neb.	48.1	81	26	55	10.7	42	S	4.82	1.38	18
	St. Paul, Minn.	42.2	65	17	48	10.3	40	SW	0.97	0.47	7
	Duluth, Minn.	34.8	67	14	53	9.5	34	NW	3.70	1.40	8
	Bismarck, N. Dak.	38.3	64	16	48	15.3	50	NW	3.23	0.90	11
	Average	43.4	72.9	21.3	51.6	11.7	42.0	.....	2.41	0.84	10
Southern Cities.	Washington City	51.4	81	31	50	7.9	35	NW	4.52	0.90	14
	Louisville, Ky.	55.5	83	29	54	9.5	34	S	7.20	3.00	13
	St. Louis, Mo.	54.0	85	30	55	12.4	42	S	7.60	2.52	12
	Savannah, Ga.	65.5	85	42	43	9.0	36	SW	0.16	0.11	6
	Leavenworth, Kan.	51.8	78	29	49	11.9	66	SW	4.90	1.15	13
	Jacksonville, Fla.	69.4	88	43	45	9.1	33	SW	0.11	0.09	2
	Chattanooga, Tenn.	60.1	83	34	49	7.5	35	W	8.28	2.96	12
	New Orleans, La.	69.0	84	51	33	12.0	40	E	10.44	7.49	8
	Memphis, Tenn.	61.7	86	39	47	9.1	42	SE	8.26	3.54	14
	Palestine, Tex.	67.6	86	44	42	8.5	29	S	4.80	1.58	10
	Average	60.6	83.9	37.2	46.7	9.7	38.2	.....	5.36	2.33	10
Western Cities.	Helena, Mont.	40.0	66	14	52	8.2	36	SW	0.72	0.24	15
	Port Angeles, Wash.	44.6	61	31	30	5.9	36	NE	1.26	0.23	17
	San Francisco, Cal.	53.1	68	44	24	9.2	36	W	1.20	0.38	7
	Salt Lake City, Utah.	47.4	73	26	47	5.5	26	NW	1.90	0.46	16
	Denver, Colo.	45.8	80	16	64	9.1	36	NE	1.75	1.10	9
	Yuma, Ariz.	70.0	98	41	57	8.6	34	W	Trace	Trace	0
	Santa Fé, N. Mex.	46.7	72	20	52	8.9	33	SW	0.69	0.49	5
	Average	49.7	74.0	27.4	46.6	7.9	33.9	.....	1.07	0.41	10

and is owing largely to the bad weather and the decrease in the grain and cotton movement. As for previous months, the Northwestern roads show the most favorable results, while the returns from the Southern roads are generally unfavorable.

A new railway across the Midland district of England connecting eastern and western ports, has been authorized, and will be built by the Lancashire, Derbyshire & East Coast Ry. Co., which has a capital of $25,000,000. Some of the plant used on the Manchester Ship Canal has been secured for this work. The line will be about 120 miles long, and will run from the ship canal docks at Warrington, near Liverpool, to new docks at Sutton, on the east coast, which will cost about $500,000. The cost is estimated at about $22,000,000, with $21,500 per mile per track and an average of $39,000 for each of the 28 stations. There will be one viaduct 272 ft. high.

The new Croton dam at Cornell's, plans for which were completed some months ago, will be built at once. At the meeting of the Aqueduct Commission on May 17, it was decided to ask for bids for its construction, to be opened June 15. The dam will be about 3 miles below the old Croton dam and 1½ miles above the proposed Quaker Bridge dam, and will cost about $5,000,000. A full description of the proposed location was given in our issue of Nov. 29, 1890.

The formal test of the Memphis bridge across the Mississippi River at Memphis, Tenn., described in our last issue, was made on May 12. The bridge is 2,597.12 ft. long and consists of five spans as follows:

No. span.	Length, ft.
1. Eastern shore span	225.83
2. Main span	790.42
3. River span	621.06
4. " "	621.06
5. Western shore span	338.75

The testing train consisted of 18 locomotives and weighed approximately 1,400 tons. The results of the test were as follows: (1) Loading span 1 with four locomotives—Span 1 depressed 3-16 in.; span 4 elevated ¼ in.; no effect on the other spans. (2) Loading span 2 with 18 locomotives—Span 1 elevated ⅝ in.; span 2 depressed 4¾ ins.; span 3 elevated 2⅛ ins.; span 4 depressed ⅝ in. (3) Loading span 1 with four locomotives and span 3 with 14 locomotives—Span 2 elevated 1¼ ins.; span 3 depressed 2⅛ ins.; span 4 depressed 1⅝ ins. (4) Spans 2 and 4, each half loaded—Span 1 elevated ¼ in.; span 2 depressed 3½ ins.; span 3 elevated 2 ins.; span 4 depressed 3⅜ ins. (5) Loading span 4 with 14 locomotives—No effect on span 1; span 2 depressed ¾ in.; span 3 elevated 1 in.; span 4 depressed 2⅝ ins.

A recording marine compass is being manufactured by the Seth Thomas Clock Co., of Waterbury, Conn. From the somewhat vague newspaper reports it seems to be a combination of a chronometer and magnetic compass provided with the necessary mechanism by which the course of the ship is traced on a roll of sensitized paper operated by the chronometer, by means of a ray of light admitted through a small aperture, the position of which changes with each change in position of the compass needle. The sensitized paper is properly lined and spaced for latitude and longitude, so that by means of the photographed line, the latitude, longitude, course and speed of the vessel are recorded for every hour of the voyage. To maintain uniformity in the photographed line, an artificial light is used both day and night.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

ROCKAWAY VALLEY.—Grading has been begun on the 7-mile extension of this railway, from Mendham to Morristown, N. J.

EAGLE'S MERE.—About 3½ miles of grading have been completed on this 6-mile railway from Sonestown to Eagle's Mere, Pa., and the track material is rapidly arriving. The line is to be completed by June 15.

PHILADELPHIA & READING.—Preliminary surveys are in progress for the proposed railway from Glenside to Wistar Station, Pa.

LAKE ERIE & DETROIT RIVER.—Bids are asked for clearing, grading, fencing and masonry for the extension of this railway from Leamington to Merlin, Ont. Plans, specifications, etc., can be procured of Joseph De Garse, Walkerville, Ont.

WELLSVILLE, COUDERSPORT & PINE CREEK.—This company will build an extension from Genessee, N. Y., two miles up the Gennessee River, to near Perryville, Pa.

PENNSYLVANIA.—Surveys are in progress for a line from McDonald, Washington Co., Pa., via Peter's Creek, to Irwin, Westmoreland Co., Pa. A portion of the line was surveyed some years ago.

CINCINNATI, HAMILTON & DAYTON.—At a recent meeting of the stockholders it was voted to increase the capital stock $4,000,000, and to issue $3,000,000 of bonds, the proceeds to be used in making improvements. It is stated that among the more important of these will be the double tracking of portions of the line and the construction of a large station at Cincinnati, O.

SANDUSKY & COLUMBUS SHORT LINE.—Work is being rapidly pushed on this line from Sandusky to Columbus, O., 108 miles. Ties are being delivered along the entire line, 140 cars of rails at the Columbus yards, 150 at Bellevue, and 160 cars will be delivered at Marion on May 20. About four-fifths of the right of way has already been secured. Two trains are now engaged in ballasting the road between Sandusky and Bellevue; 200 teams are at work between Bellevue and Bucyrus, a distance of 34 miles; 100 teams are at work between Bucyrus and Marion and 150 between Delaware and North Columbus. No work is being done between Delaware and Marion, as the country is very flat and the ground is full of moisture. As soon as the weather settles the number of teams between the points mentioned will be largely increased. The contractors for masonry and timber work are scattered along the entire line, and the work is being pushed with all the energy possible.

BUFFALO, ROCHESTER & PITTSBURG.—A report is in circulation that this company has entered into an agreement with the Philadelphia & Reading R. R. Co. and Beech Creek R. R. Co., whereby it will built a line from Du Bois, Pa., to a connection with the Beech Creek R. R., at Clearfield, Pa., a distance of about 20 miles. The object of the line is to give the Philadelphia & Reading R. R. a connection with the soft coal lands penetrated by the Buffalo, Rochester & Pittsburg R. R.

SNOW FORK & HOCKING.—This company has been organized in Ohio to build a railway from New Straitsville to Athens, O. Pres., David Lee, Zanesville, O.; Secy., S. P. Peabody, Columbus, O.

Projects and Surveys.

DAYTON, LEBANON & CINCINNATI.—It is stated that the contracts for this road, from Dayton to Lebanon, O., 25 miles, will be let this month.

BINGHAMTON & STATE LINE.—Chartered in New York to build a railway from Binghamton to a point on the Pennsylvania state line, 13 miles south. The directors are Chas. M. Dickson, Joseph P. Noyes, Ed. E. Kattell, Fred. E. Ross, Edmund O'Connor, Scott Brandt, Harry Ross, Walter P. Pratt and Ward Ives, all of Binghamton.

NEW YORK.—Two routes are being considered for the proposed line from the Hudson River to the Pennsylvania coal fields, noted last week. One is from Bloomville, N. Y., to Deposit, Pa., 50 miles, and the other is from Arkville, N. Y., to Deposit, 60 miles. It is stated that the first mentioned line can be built for about $12,000 or $15,000 per mile.

MIDDLESEX VALLEY.—Chartered in New York to build the proposed railway from Naples, N. Y., to Geneva, N. Y., 23¾ miles. Among the incorporators are Frederick H. Patterson, New York City, Wm. D. Stratton, Middletown, N. Y., and C. H. Wildes, Riverdale, N. Y. The principal offices will be in New York city.

SUGAR VALLEY.—The Lock Haven, Pa., "Express" says: "The citizens committee appointed to secure free right of way through Sugar Valley for the new railway, has about completed its work and has been successful. The committee are J. B. Barner, Dr. J. H. Houtz, Dr. W. R. Goodman and John Morris. Money enough has been subscribed to purchase the right of way where it was not given free."

CATARACT CONSTRUCTION CO.—This company is completing arrangements for building a transfer railway connecting the mills on its property with the railways entering Buffalo. A press dispatch says: "The new road will be built entirely upon the company's land, and will extend from the Lockport branch of the New York Central & Hudson River R. R., on the North of the Buffalo and Falls branches of the Central and Erie along the upper river. It will connect with the Erie at grade by a switch on lot No. 48 of the mile reserve, just west of the Howard farm. It will also cross the Central and Erie tracks and the river road on an elevated track 22 ft. high and then follow the shore line of the river down stream to the site of the Niagara Falls Paper Co. This road will be 5½ miles long. A single track will be first built, but it will double-tracked later. While the road is principally for freight service a passenger service will soon be established for the benefit of the many who will probably make their homes along the line. The work of building will begin at once."

MINERAL RANGE, HANCOCK & CALUMET.—The surveys for this short railway from Calumet, Mich., south to Lake Linden, noted last week, have been commenced, and according to the local papers, work will begin at once.

WASHINGTON & CHESAPEAKE BEACH.—Ch. Engr. L. H. Hyer, Washington, D. C., writes us that this road has been finally located, and that all financial matters are completed. The line begins at a point on the Philadelphia, Wilmington & Baltimore R. R., one mile south of Landover, Md., just outside of the District line, and runs southeast through Upper Marlboro, and reaches the Chesapeake Bay at a point four miles north of Plum Point, a distance of 28 miles. About 800 acres of land belong to the company at the terminus on the bay where it intends to establish a summer resort. The road will have but four curves. The maximum grade is 1½%, three of the curves are 1°, and the fourth is 2°. There are two tangents over eleven miles each, and one plate girder drawbridge, 180.5 ft. long, having an 84 ft. clear opening on each side of the center pier. The Secretary of War has approved the bridge plans, and the work will commence at an early date. Bids are all in for the bridge and roadbed. The grading is all earth and will run about 40,000 cu. yds. per mile, and 70-lb. steel rails will be used. There will be little, if any, trestle work. Cast iron pipe will be used for culverts. It is expected that the road will be in operation by November next.

ST. LAWRENCE RIVER.—This company has applied to the Dominion Parliament for a charter to build a railway from the village of St. Lambert to Sorel, P. Q.

WYANDOTTE & DETROIT.—This company has been chartered in Michigan to build a railway from Detroit, Mich., to Toledo, O.. A press dispatch says: "Entrance into Detroit, it is said, will be had over the tracks of the Wabash system. It is proposed to build the road as a private enterprise, unconnected with any of the existing systems, and negotiations are said to have been made with the Ohio Central; Cincinnati, Hamilton & Dayton; Wheeling & Lake Erie, and Toledo, Chicago, St. Louis & Kansas City, whereby those roads will become the lessees of the new road and operate their systems over it into Detroit."

Southern.—Existing Roads.

OHIO VALLEY.—Grading on this line from Gracey to Hopkinsville, Ky., is nearly completed and track-

laying has been begun. It is expected to have the line completed by Aug 1.

CHESAPEAKE & OHIO.—The contract for building the branch from the main line near the mouth of the Gauley River, in West Virginia, up that stream, a distance of 7½ miles, has been let to Gooch, Rinehart, Carpenter & Co., of Staunton, W. Va. Work is to begin at once.

GURLEY'S & PAINT ROCK VALLEY.—About 200 men are now at work on this Alabama railway. The contract for building 30 miles to the base of Cumberland Mt., from Gurley's, Ala., and then 14 miles to the Tennessee River, has been let to Mosley, Allen & Co., of Virginia. The first 5-mile section is to be completed in 60 days.

BRISTOL, ELIZABETHTON & NORTH CAROLINA.—The construction company that is building this road is increasing its capital stock to provide funds for completing the line.

CHARLESTON, CINCINNATI & CHICAGO.—A press dispatch from Bristol, Tenn., dated May 13, says: "That portion of the Charleston, Cincinnati & Chicago R. R., which lies in Tennessee, 75 miles, was sold yesterday at Johnson City to satisfy a debt. It was bid in by Samuel Hunt for the stockholders for $200,000. The construction cost $200,000 and the work began in 1889. The contractors, MacDonald, Shea & Co., had a debt of $450,000 against it. William Kenefick held a debt of $140,000 against it. Work, which has been suspended for so long will now be resumed. The bid of $200,000 is not final and will be held open until July."

PIEDMONT, LANEY & BIRMINGHAM.—A correspondent writes us that surveys will soon begin for an extension of this railway to Birmingham, Ala.

HARRIMAN COAL & IRON.—Track laying will soon begin on the line to Brushy Mt., 14 miles from Harriman, Tenn., which was graded last year.

PADUCAH, TENNESSEE & ALABAMA.—Contracts for the extension from Hallow Rock, Tenn., to a connection with the Tennessee Midland R. R., will probably be let this summer.—At the recent meeting of the stockholders of the Tennessee Midland R. R., it was voted to issue first and second mortgage bonds amounting to $11,000 and $9,000 per mile, respectively, and to enter into a traffic contract with the Paducah, Tennessee & Alabama R. R. A new Board of Directors was also elected.

Projects and Surveys.

SUWANEE RIVER PHOSPHATE CO.—It is stated that this company will build 35 miles.

ASHEVILLE, N. C.—A correspondent informs that the people of Buncombe Co., N. C., held a mass meeting on May 7 to promote the construction of several railway lines from Asheville, N. C., to points where connections can be made with existing roads. Among the lines under consideration are one to Bristol, Tenn., or some other point on the Norfolk & Western R. R., one south to Atlanta, Ga., or Greenville, S. C., one to Rutherfordton, N. C., and one to Knoxville, Tenn., or some other desirable railway point. The county will make liberal contributions in bonds in aid of these lines, and their routes are through rich timber and mineral sections. Natt. Atkinson, Asheville, N. C., is interested.

Northwest.—Existing Roads.

YANKTON, NORFOLK & SOUTHWESTERN.—It is stated that only about one mile of this line from Yankton, S. Dak., to Norfolk, Neb., is under construction at present, but that bids for the construction of the entire line are being advertised for.

DULUTH & WINNIPEG.—It is stated that this company has about completed arrangements for building a branch to the Buckeye and Diamond mines, about 20 miles long.

BURLINGTON, CEDAR RAPIDS & NORTHERN.—The contract for building 40 miles of the extension from Forest City, Ia., west, has been let to Kimball & McNamara. The route of the extension will be from a point about 2½ miles north of Forest City, Ia., to a point 10 miles west of Ledyard, Ia. It is stated that construction will begin at once.

DULUTH, MISSISSIPPI & NORTHERN.—This company has been chartered in Minnesota by A.W. Wright, Alma, Mich., Chas. H. Davis, Saginaw, Mich., and others. The line is to run from a point on the Duluth & Winnipeg R. R., north about 46 miles, and construction is already in progress.

CHICAGO, FT. MADISON & DES MOINES.—The contract for the extension of this railway from Libertyville to Ottumwa, Ia., 25 miles, has been let to Mallory, Cushing & O'Keefe, of Omaha, Neb., Work will begin at once upon portions of the line, but the line will not be put under construction as a whole until the weather settles.

ST. LOUIS, GRAND TOWER & SOUTHERN.—It is again reported that the contracts have been let for building this railway from East St. Louis, Ill., along the east bank of the Mississippi River to Cairo, Ill., via Chester and Grand Tower. The contractors are said to be Cockerill & Brown, of St. Louis, Mo., and the contracts to cover the first 90 miles from East St. Louis south.

Projects and Surveys.

ST. LOUIS, CHICAGO & ST. PAUL.—Chartered in Illinois to build a railway from East St. Louis, Ill., via Alton, Ill., to Springfield, Ill. The principal office will be at Alton, Ill. Among the stockholders are Clark L. Whiting, of East St. Louis, Ill., and Henry O'Hara, of St. Louis, Mo.

QUINCY, BEARDSTOWN & HAVANA.—Chartered in Illinois to build a railway from Quincy to Havana, Ill., The principal office will be at Quincy, Ill. Among the incorporators are Rich F. Newcomb, Fred W. Meyer, and Proctor Taylor, of Quincy, Ill., and David Halstead, Keithsburg, Ill.

BRAINERD & NORTHERN MINNESOTA.—This company has been organized in Minnesota to build a railway from Brainerd, Minn., north, to the International line, between Rainy Lake and the Red River. The principal place of business will be at Minneapolis, Minn. Among the incorporators are Wm. B. Ransom, Jas. E. Glass and Jas. A. Kellog, all of Minneapolis, Minn.

Southwest.—Existing Roads.

HOUSTON & TEXAS CENTRAL.—According to the local papers there is a strong probability that the extension from Albany to Anson, Tex., will be built this season.

Projects and Surveys.

HOUSTON BELT.—It is stated that this company will let the contracts for building its line at Houston, Tex., by June 1, and that it is expected to have the line completed by Sept. 1.

LAPORTE & HARRISBURG.—A press dispatch from Houston, Tex., says: "The Laporte syndicate which is making great improvements at Morgan's Point, between Houston and Galveston, signed a contract for the building of a railway from Laporte to Harrisburg, connecting with the Galveston, Houston & Henderson R. R., and work will begin at once."

SPRINGFIELD, YELVILLE & WHITE RIVER.—This company has been chartered in Missouri to build a railway from the mouth of the Buffalo River, Marion Co., to George's Creek, a distance of 20 miles. The officers are, Pres., Edward H. Webster, Kansas City, Mo.; Sec., W. R. Jones, Yellville, Mo., and Treas., E. W. Homan, Washington, D. C.

Rocky Mt. and Pacific.—Existing Roads.

SOUTHERN PACIFIC.—In a recent interview C. P. Huntington is reported as saying that various improvements and additions to this system, which will cost between $4,000,000 and $5,000,000 have been commenced. About $3,000,000 will be expended in constructing the line from Santa Margarita to Ellwood, Cal. The other work consists in changes in the line at Pecos, Tex., and Dragon Summit, Ariz., and the removal of the line from the bed of the Gila River east of Yuma, Ariz., and the construction of several short lines in the San Joaquin Valley.

ASTORIA & PORTLAND.—About 400 men are now at work on this line between Portland and Astoria, Ore., and this force will be rapidly increased. The work is very heavy, there being several tunnels on the line.

Projects and Surveys.

TACOMA & EASTERN.—The surveys for the proposed railway from Tacoma to Mineral City, Wash., 70 miles, have been completed and tracklaying is now in progress. Ch. Engr., J. O. Jamieson, Tacoma, Wash.

Foreign.

MEXICAN INTERNATIONAL.—It is stated that the immediate construction of a branch from Monelova Station to the great Coahuila mining camp of Sierra Mojada, about 140 miles, is contemplated.

MEXICO.—A concession has been granted to Gen. Camano, S. E. Halberstadt, Rudolph Weiser, Pedro Alcocer and Juan Zaleiva to built a broad gage railway from the City of Mexico to the port of Zihuatanejo on the Pacific coast, south of Manzanillo. The subsidy is $8,000 per kilometer.

ELECTRIC RAILWAYS.

BATH, ME.—An electric railway is projected, in which W. M. Brown and W. J. Wilson, Chief Engineer of the Easton Electric Supply & Construction Co., are interested.

SOUTHBRIDGE, MASS.—The Southbridge, Sturbridge & Brookfield Ry. Co., noted last week, has elected officers: Pres., James L. Fisk, Cambridge; Secy. and Ch. Engr., A. C. Moore, Sturbridge. Surveys for final location are now being made.

PORTSMOUTH, N. H.—The Portsmouth Street Ry. Co. has applied for permission to adopt the trolley electric system.

PORT RICHMOND, N. Y.—A franchise for a line to Southfield has been granted to Erasmus Wiman, and work will be commenced shortly.

BUFFALO, N. Y.—A line along the Genesee road to Bowmansville and the new town of Depew, about 6½ miles, is projected. Charles Roessler, President of the Buffalo Carriage Co., is interested, and the cost is estimated at $70,000.

STEUBENVILLE, PA.—A line to Mingo Junction is projected by C. L. Magee and Geo. P. Dravo, of Pittsburg.

PHILADELPHIA, PA.—The Philadelphia Traction Co. has secured an ordinance for the introduction of overhead wires for the trolley system.

NORRISTOWN, PA.—The Norristown Passenger Ry. Co. has appointed a committee to investigate the question of electric traction.

CLEVELAND, O.—The Woodland Ave. & West Side Ry. Co. will adopt the trolley electric system, and put up the plant and equipment this summer.

CINCINNATI, O.—The Cincinnati, Hamilton & Dayton R. R. will build an electric line for passengers and baggage from its present terminus to a station near the center of the city, instead of extending its tracks through the city.

DETROIT, MICH.—The Fort Wayne & Elmwood Ry. Co. has decided to operate its road by electricity. The Citizens' Street Ry. Co. has awarded the contract for electrical equipment for its Jefferson Ave. line to the Detroit Electrical Works, at $100,000. The company may also make a trial of the electric conduit system of the American Engineering Co., New York. (Eng. News, March 19.)

COLUMBUS, IND.—An electric street railway company has been organized by Capt. W. J. Lucas, of the First National Bank, and others, with a capital stock of $50,000.

BELLEVILLE, ILL.—The Belleville & St. Louis Ry. Co. will build a double track road to East St. Louis, using one for freight traffic by steam power, and the other for passenger traffic by electric power. Work will be started in June.

DENVER, COLO.—An electric railway to Elyria and Swansea is to be built by the Denver Tramway Co.

LONDON, ONT.—An electric railway, 5 miles long, is projected by Charles H. Ivey, A. M. Smart and T. S. Hobbs.

BRANTFORD, ONT.—The Brantford Electric Street Ry. Co. will extend its road three miles to Cainsville.

NEW COMPANIES.—Bloomfield Street Ry. Co., Pittsburg, Pa.; $12,000; 2 miles; Joshua Rhodes, J. Taggart and W. M. Adams. Delaware County & Philadelphia Electric Ry. Co.; $120,000; 20 miles; John B. Robinson and S. L. Kent. West Chester, Unionville & Western Ry. Co., West Chester, Pa.; $100,000; Pres., John H. Marshall, Unionville. Lewiston & Youngstown Ry. Co., Lewiston, N. Y.; $75,000; 7 miles; W. D. Hough, W. A. Philpotte and Spencer J. Laurence. Popperton Place & Fort Douglas Rapid Transit Co., Salt Lake City, Utah. Spokane & Coeur d'Alene Ry. & Navigation Co., Spokane, Wash.; electric railways; $500,000; N. S. Norman and others.

ELEVATED RAILWAY.

BROOKLYN, N. Y.—The Brooklyn Elevated R. R. Co. will take steps at once to build its extension to Fort Hamilton.

HORSE AND MOTOR RAILWAYS.

WORCESTER, MASS.—Worcester & Millbury Street Ry. Co.; $150,000; 8 miles; S. Winslow, T. M. Roger and G. S. Hoppin.

NEW YORK.—The West Side Ry. Co. proposes to build a line on Eleventh and West End Aves. Pres., George D. Patten; Secy., L. F. Wilson. The syndicate which owns the Broadway line, proposes to extend the Ninth Ave line from 66th to 125th St.

WASHINGTON, D. C.—The Washington, Fairfax & Alexandria Ry. Co. will build its line at once, and operate by horses for one year, after which mechanical traction will be required.

TOLEDO, O.—The Toledo & Edgewater Steam Car Co. will build a motor line. Pres., George H. Allen; Secy., J. E. Gunckel.

OREGON CITY, ORE.—The East Portland Motor Co. proposes to build a motor line on Main St.

HIGHWAYS.

MASSACHUSETTS.—Proposals for a new highway from Granville to Southwick, will be received until June 1 by the Selectmen of Granville. Geo. N. Miller, of Springfield, is the Engineer.

NEW JERSEY.—The town of Rutherford will vote, May 31, on a proposition to issue $50,000 in bonds for macadamized roads.

VIRGINIA.—The Augusta Co. Board of Supervisors has decided to macadamize the Rockbridge road at a cost of $15,000. Carter Harrison, of Staunton, is the engineer.

KENTUCKY.—The Biddle & Lytles Fork Turnpike Co. has been organized at Biddle by W. S. Bailey, J. F. McFarland and L. Dudley; $10,000.

BRIDGES, TUNNELS AND CANALS.

WATERVILLE, ME.—G. F. Allen, Wm. Ayer and W. H. McCartney, Bldg. Com., will give details of a new bridge to be erected near Messalonskee Lake. This bridge is to replace the Coombs bridge, which is now considered unsafe.

FARMINGTON, MASS.—This town has appropriated $6,000 for a new iron bridge over Sudbury River on Eastern Ave.

CHELSEA, MASS.—A new iron bridge is to replace the wooden one from this place to Charlestown. The bridge is to have three divisions, one over the South Channel 360 ft., an iron viaduct over Mystic wharf 1,000 ft. and approaches to bridge 575 ft., and will cost $270,000. The bridge will be built by the Boston & Maine R. R., the city paying 5% of the expense.

WINSTED, CONN.—The town will replace the old bridge near Wilson's on the Riverton road at once.

HERKIMER, N. Y.—The contract for the construction of iron bridges on South Washington St. as approaches to the river bridge has not yet been let. Commissioner of Highway Kay will again advertise for bids.

ROCHESTER, N. Y.—Bids will be received until May 23 for removing the old bridge at Clarrisa St., and replacing it with a new structure. Plans and specifications can be seen at the office of the City Surveyor. The plans for the proposed stone arch bridge at Court St. have been completed. They call for a structure 64 ft. wide, with a 40-ft. roadway and two 12-ft. sidewalks. There will be six spans 52 ft. each and two spans 30-ft. each. The estimated cost is $135,000.

BLOOMSBURY, N. J.—Warren & Huntington counties will build an iron bridge over Musconetcong Creek at Bloomsbury.

MANASQUAN, N. J.—The Highway Committee has been instructed to procure plans for a new bridge across Silver Lake on Eighth Ave., and for repairs to bridge on Ninth Ave.

ALLEGHENY CITY, PA.—The Allegheny, McKee's Rock Bridge Co., capital $5,000, has been incorporated to construct a bridge over the Ohio River, from the foot of Wilkens St. to McKee's Rocks. Walter H. Shaw, John Johnson.

BUTLER JUNCTION, PA.—The Livermore four-span bridge and the Buffalo Creek bridge are to be immediately rebuilt. Town Clerk will give details.

PHILADELPHIA, PA.—An iron truss bridge will be built across Broad St. over the Philadelphia & Reading R. R., tracks, of which there will be four tracks.

CUMBERLAND, MD.—The West Virginia Central & Pittsburg R. R. will erect an iron trestle half a mile in length to replace the present wooden one.

ST. AUGUSTINE, FLA.—The St. Augustine Bridge Co. has been incorporated by W. W. Dewhurst, Matthew Hays, Allen Wood and others to build, maintain and operate a toll bridge between St. Augustine and Anastasia Island. The capital stock is $50,000.

WASHINGTON COURT HOUSE, O.—Sealed proposals will be received until June 9 for furnishing material and constructing a bridge over Deer Creek, north of Waterloo, in two spans, masonry estimated at 300 perch, super-structure, high truss, iron bridge, span 100 ft.; also a bridge over Milliken Ave., masonry estimated at 200 perch, super-structure, high truss iron bridge, 100-ft. span.

SAGINAW, MICH.—Sealed proposals will be received at the office of the Board of Public Works until May 28 for the construction of the iron super-structure of the swing span in the Mackinaw St. bridge. The work will consist of one swing span 196 ft. long, to have a roadway 18 ft. wide in the clear and two sidewalks, each 5 ft. wide. R. W. Roberts, Cy. Engr; Alfred Davis, Clerk.

OMAHA, NEB.—The city's committee on viaducts has approved of the plans for new viaducts on 15th and 16th Sts. They are to cost $150,000 and $100,000 respectively. It is expected they will be completed by Nov. 1.

OSAGE, IA.—A bridge is to be rebuilt over the Wapsie River at Riceville, money for which has been appropriated. E. E. Prime, Co. Aud.

SPIRIT LAKE, IA.—The Boone Transportation Co. will build a new railway bridge at this place to cost $10,000.

TOPEKA, KAN.—The city will build a wire suspension bridge over the Kaw River to cost $62,000.

WATER-WORKS.

New England.

GREEN LAKE, ME.—It is reported that a reservoir is proposed.

BELLOWS FALLS, VT.—It is reported that Engr. E. A. Ellsworth, has been engaged to report on a new supply.

BOSTON, MASS.—The bids for the new 20,000,000-gallon high service pumping engine, opened May 12, were as follows: Holly Manufacturing Co., Lockport, N. Y., $153,950; L. P. Morris & Co., Philadelphia, $144,239; Geo. F. Blake Manufacturing Co., Boston, $130,000; N. F. Palmer & Co., New York, $124,000.

BROOKLINE, MASS.—The highest bid for the construction of a 1,000,000-gallon covered reservoir was $27,893, from John Cavanaugh & Co.; the lowest, $23,773, from D. H. Cram.

IPSWICH, MASS.—The Board of Trade has concluded that works could be built for $75,000.

PROVINCETOWN, MASS.—Engr. Louis Haines, Boston, informs us that the town has voted to build works, and that investigations regarding a supply are being made, L. N. Paine, A. L. Putnam and J. D. Adams, Comrs.

WEST BRIDGEWATER, MASS.—Geo. C. Howard is on a committee to ascertain how many people desire works.

BRIDGEPORT, CONN.—It is reported that the company will build an 8,000,000,000-gallon reservoir, to be formed by an earth dam with a concrete core. It is said that no contracts have yet been let.

Middle.

ALBANY, N. Y.—The new Water Commissioners have been appointed by the Mayor and include Elnathan Sweet, formerly State Engineer. It is expected that important improvements to the works will be made.

CARTHAGE, N. Y.—Works to be owned by the village are under discussion.

HOBART, N. Y.—It is reported that the company will build another reservoir.

RICHMONDVILLE, N. Y.—W. H. Cowan, of Stamford, has secured a franchise for works here, but it is reported that he will not begin construction this year.

WESTPORT, N. Y.—The Westport Water Co. is laying mains for its works.

LANCASTER, PA.—Bids will be asked for a 10,000,000-gallon pumping engine.

PRESTON, PA.—A small system of works is talked of.

RENOVO, PA.—It is reported that the South Renovo Water Co. will build a new reservoir.

ROYERSFORD, PA.—It is reported that the company is to change its source of supply to the Schuylkill River and to put in filters. New Worthington pumps have been bought.

SHENANDOAH, PA.—The borough will vote in June building works. A company now furnishes a supply.

WORMLEYSBURG, PA.—It is stated that works will be built by a company to supply this and other suburbs of Harrisburg. A 2,000,000-gallon pump, formerly used by Harrisburg, will force water from the river to a reservoir.

CAMBRIDGE, MD.—The people have authorized the Council to issue $50,000 of bonds for works.

ARLINGTON, MD.—The West Arlington Water Co. has been incorporated by Chas. G. Hill, Henry F. New and others, of Baltimore, to supply West Arlington and other suburbs of Baltimore; capital stock, $50,000. A well is being sunk and a stand-pipe is proposed.

Southern.

MARTINSVILLE, VA.—It is reported that the people will vote on building works.

MOUNDSVILLE, W. VA.—Works are still wanted.

APALACHICOLA, FLA.—It is proposed to issue $12,000 of bonds for works. The issue must be voted upon by the people.

KEY WEST, FLA.—The "Democrat" says works must be built, and proposes a bond election.

ALEXANDRIA, LA.—A franchise for works has been granted to Geo. O. Watts. It provides for the completion of works within nine months.

ATHENS, TENN.—It is reported that a movement is on foot to supply the town from the North Athens works. Works were built here by a company in 1888.

STANFORD, KY.—The Stanford Water, Light & Ice Co., it is reported, has been incorporated; capital stock, $100,000.

North Central.

BRYAN, O.—The people have again voted in favor of works.

GLENDALE, O.—It is reported that works will be built.

WEST MILTON, O.—The people have voted, 143 to 43, for works.

CONNERSVILLE, IND.—Improvements to the works are under discussion.

LOGANSPORT, IND.—Bonds to the amount of $12,000 will be issued for new mains.

CENTERVILLE, MICH.—The town is considering the issuing of bonds for the establishment of works.

JACKSON, MICH.—Extensive improvements are proposed.

L'ANSE, MICH.—Bids are wanted by the village until May 26 for constructing a gravity system of works, including a timber and earth dam, a stone reservoir and the furnishing of all material. S. Kinney, Chn. W.-Wks. Com.; J. P. Edwards, Engr., Houghton, Mich.

MAYVILLE, MICH.—It is reported that bonds are proposed for works.

PENT WATER, MICH.—Works are proposed and a special election may be called to settle the question of ownership. Sands & Maxwell, it is reported, desire the franchise.

ROMEO, MICH.—An additional $8,000 has been voted for works, and it is proposed to add a stand-pipe and lay more mains.

ATLANTA, MICH.—Preparations are being made to build works, including a stand-pipe or tank.

AUSTIN, ILL.—It is reported that the trustees of Cicero have made a 24-years contract with the Berwyn Water, Fuel & Light Co., to supply that portion of the town lying south of Twelfth St., and that the company will sink artesian wells and lay pipes for the purpose.

CARBONDALE, ILL.—A company has offered to build works, provided the town will take 25 hydrants at $50 each.

CHICAGO, ILL.—Bids will be received until May 20 for furnishing and delivering at the city's yards such special castings for iron water pipe as shall be required for use during the term ending May 31, 1893. J. Frank Aldrich, Comr. of Pub. Wks.

MONTICELLO, ILL.—The contract for a part of the works has been let to Geo. C. Morgan, Chicago.

MILWAUKEE, WIS.—Bids will be received until May 24 for furnishing material and putting in foundations for an 8,000,000-gallon pumping engine and boilers. G. H. Benzenberg, Chn. Comrs. Pub. Wks.

Northwestern.

MUSCATINE, IA.—The company is considering the putting in of a filtering plant and is talking of erecting a stand-pipe.

ROCK VALLEY, IA.—It is reported that the citizens contemplate the establishment of works.

WOODBINE, IA.—It is reported that the people have voted to build works at an estimated cost of $8,000 to $10,000.

BENKLEMAN, NEB.—Works question is again under discussion.

O'NEIL, NEB.—F. L. Burrell, Fremont, informs us that he has a contract for a small plant here, including a 600,000-gallon pump, 10×100-ft. stand-pipe 1 1-3 miles of cast iron pipe and 12 Mathews hydrants.

STANTON, NEB.—This place proposes to build works. F. L. Burrell, Fremont, informs us that a 500,000-gallon pump is proposed, also a 10×50-ft. stand-pipe, with provision for adding 50 ft. Adam Pilger, Chr. Bd.

HOT SPRINGS, S. DAK.—It seems that a franchise for works has been granted, but is held by some to be invalid.

RAPID CITY, S. DAK.—The city has sold $35,000 of bonds.

BUTTE, MONT.—The city is again advertising for proposals for a franchise.

DILLON, MONT.—May 28 the people will vote on issuing $25,000 of bonds for works.

Southwestern.

SPRINGFIELD, MO.—The city has ordered the company to lay about one mile of mains.

BROWNWOOD, TEX.—Address the Mayor regarding proposed improvements.

OAK CLIFF, TEX.—A committee has been appointed to report on works to be built by the town.

OKLAHOMA CITY, OKLA. T.—J. A. Courtney, Cy. Engr., informs us that a franchise has been granted to D. H. Scott & Co., Topeka, Kan., for a 2,000,000-gallon direct pressure pumping system of works, with a supply from wells.

BESSEMER, COLO.—Works are projected.

Pacific.

SAN DIEGO, CAL.—The City Engineer has estimated that a distribution system could be put in for $500,000.

SANTA ROSA, CAL.—Another special water committee has been appointed by the Council to report on buying the existing private works or building new ones.

VALLEJO, CAL.—June 11 the people will again vote on the issuance of $250,000 bonds for city works. The proposition was defeated two months ago. Works were built in 1870 by a company.

OGDEN, UTAH.—The South Ogden Water Co. has been incorporated to supply South Ogden with water for all purposes. Pres., Sidney Stevens; Secy., Sidney O. Stevens; authorized capital stock, $500,000.

ARTESIAN WELLS.

BORDENTOWN, N. J.—Subscriptions are being solicited for an artesian well to be sunk in the central part of the town.

MEMPHIS, TENN.—It is reported that the Artesian Water Co. has received permission from the Council to sink several wells in different parts of the city.

IRRIGATION.

PHOENIX, ARIZ.—A company was recently incorporated to build a reservoir just below the junction of Tonto Creek and Salt River. It is reported that the reservoir will have a capacity of over 750,000,000,000 gallons.

SEWERS.

BURLINGTON, VT.—A special committee has been appointed to devise plans for both temporary and permanent sewage disposal. The City Engineer can give information.

ST. ALBANS, VT.—The Board of Trade desires the Village Trustees to employ L. A. Taylor to examine the present system and report estimates for an improved outlet.

SOUTHBRIDGE, MASS.—Surveys and plans for a system of sewers are being made by A. C. Moore, C. E., of this place.

WAKEFIELD, MASS.—Surveys for a system are being prepared by Louis Hawes, Boston.

BROCKTON, MASS.—E. L. Brown, ex-City Engr., has offered to design a system of sewers and sewage disposal wholly within the city limits, satisfactory to the State Board of Health, for a population of 100,000. The bill authorizing the city to take lands for sewage disposal in Easton and West Bridgewater, has failed to pass the legislature.

LOWELL, MASS.—The Committee on Sewers has voted to build sewers in six streets.

WESTFIELD, MASS.—The contract for 25,000 ft. of pipe has been awarded to J. S. Clark, Westfield, at $2,656, and that for laying the pipe and building manholes to J. E. Brooks, New York, at $12,398.

PROVIDENCE, R. I.—The Commissioner of Public Works has been authorized to contract for 2,000,000 bricks for lateral sewers. The City Engineer is preparing plans for sewer extensions.

NEW HAVEN, CONN.—The Committee on Sewers has recommended that sewers be laid in eight streets.

WATERBURY, CONN.—The Sewer Board has recommended a sewer in the Brooklyn district, to cost $15,000.

BROOKLYN, N. Y.—Sewer bonds for $1,500,000 have been authorized, and plans have been completed for a sewer system in Ward 26.

GOUVERNEUR, N. Y.—Plans have been prepared for a system estimated to cost $38,000. A vote will be taken May 31.

CLINTON, N. Y.—The Sewer Commissioners will receive bids until June 1 for constructing the proposed sewers, after which the question will be submitted to a vote of the citizens. The plans were prepared by A. M. Scripture, New Hartford, and the estimated cost is $20,000; 6 to 20-in. vitrified pipe will be used.

NEWBURG, N. Y.—The City Engineer has been instructed to prepare plans for a system of sewers in West Newburg.

NEW YORK, N. Y.—Bids will soon be asked for several important contracts, including the 134th St. outlet sewer, which is 9,498 ft. in length, and has 2,448 ft. of brick sewer.

UTICA, N. Y.—Plans have been prepared for a system of sewers for the west part of the city, the cost not to exceed $40,000.

ELIZABETH, N. J.—Bids are asked until May 26 for two sewers: 970 ft. of 30×45 ins. brick; 1,360 ft. 18-in. pipe; 800 ft. 15-in. pipe; 175 ft. 12-in. cut-out, 28 manholes, etc. Patrick McKeon, St. Comr.

RUTHERFORD, N. J.—An election will be held May 31 to vote on issuing bonds for $25,000 for sewers, and $30,000 for macadamized roads.

HARRISBURG, PA.—Bids are asked until May 24 for a 30-in. brick sewer. A. U. Zarker, Highway Comr.

LANCASTER, PA.—Bids are asked until May 24 for 24 to 48-in. sewers in four streets. Henry Drachbar, St. Comr.

LANDSDOWNE, PA.—The Landsdowne Sewerage Co. has been organized; capital, $5,000.

LOCK HAVEN, PA.—The City Engineer is preparing plans and estimates for a sewer through the city.

NEWPORT, KY.—B. R. Morton, Cy. Engr., has prepared plans for two sewer districts, estimated to cost $260,000.

CRAWFORDSVILLE, IND.—Prof. Chas. Brown, Schenectady, N. Y., has addressed the citizens upon the subject of sewerage. It is reported that a system will be constructed.

LOGANSPORT, IND.—Bids are asked until June 1 for 4,018 ft. of ingle ring brick sewer, 16×24 to 24×36 ins., and 8,500 ft. of 8 to 24-in. vitrified pipe sewer. Geo. M. Cheney, Cy. Engr.

CEDAR RAPIDS, IA.—Bids are asked until May 26 for six miles of pipe sewer. J. D. Wardel, Cy. Engr.

SAGINAW, MICH.—Bids are asked until May 28 for 18,578 ft. of 9 to 18-in. sewer pipe, 12,000 ft. of 3-in. drain tile, 3,600 bbls. cement, 97,725 lbs. castings, etc. R. W. Roberts, Cy. Engr.

FARGO, N. DAK.—Surveys are being made for the extension of the sewerage system.

SIOUX FALLS, S. DAK.—The City Engineer has been instructed to correspond with engineers concerning surveys for a system. The estimated expense is about $100,000.

DENVER, COLO.—The City Engineer has been directed to prepare plans for sewer extensions, and bids will soon be asked for the construction.

OGDEN, UTAH.—The Committee on Sewers has voted to construct sewers to cost $14,000.

OLYMPIA, WASH.—Plans for a system have been prepared by G. M. Miller, New Whatcom. The total length is 10 miles, and estimated cost, $110,000. The City Council has voted to spend $16,000 in immediate construction. Millard Lemon is City Engineer.

STREETS.

NEW HAVEN, CONN.—The Committee on Streets has recommended that $75,000 be spent in widening and improving Grand Ave., and St. John St.

BUFFALO, N. Y.—The Department of Public Works asks bids until May 24 for the repair of all streets paved with asphalt; also until May 25 for paving three streets with asphalt, two with Medina sandstone, and one with bituminous rock. Petitions have been approved for paving four additional streets with asphalt. Contracts have been awarded to the Barber Asphalt Co., at $20,879; German Rock Asphalt Co., $14,487, and Buffalo Paving Co., $14,199.

NEW YORK, N. Y.—Bids will soon be asked for 22,000 sq. yds. of granite block pavement; 4,000 sq. yds. of trap block; 4,350 cu. yds. of filling, etc., in Ward 23. Contracts for granite block paving have been awarded to Thos. Gearty, at $56,840, and J. G. Smith, at $28,571.

OLEAN, N. Y.—About $200,000 will be spent in public improvements this summer. The Council has voted to pave one street.

TROY, N. Y.—The City Engineer has completed profiles for paving four streets with asphalt; total length, 15,613 ft.

MONTCLAIR, N. J.—Bids are asked until May 26 for ¾ and 1½-in. broken stone; also, for grading, macadamizing and improving streets.

ELIZABETH, N. J.—Bids are asked until May 26 for 4,000 sq. yds. trap block paving, 1,800 ft. curb resetting, 952 sq. ft. bridge stone. Patrick McKeon, St. Comr.

NEWARK, N. J.—The Board of Streets has voted to pave 12 streets, including four with asphalt and six with granite blocks.

PITTSBURG, PA.—It is proposed to issue bonds as follows: Street improvements, $2,000,000; parks, $2,000,000; free bridges, $1,000,000.

PHILADELPHIA, PA.—The Director of Public

Works will open bids May 23 for paving three streets with sheet asphaltum, and one street with macadam.

CANTON, O.—The City Clerk will receive bids until May 30 for paving one street with brick on concrete.

CINCINNATI, O.—Linn St. is to be paved with brick at an estimated cost of $75,221.

COLUMBUS, O.—The contract for paving South High St. with Hallwood blocks has been awarded to N. B. Abbott & Co.; estimate, $55,189.

ELMWOOD PLACE, O.—Bids are asked until May 28 for improving two streets. John Kindel, Cy. Clk.

TERRE HAUTE, IND.—The City Clerk will receive bids until June 7 for paving two streets with screened gravel, and constructing brick sidewalks in two streets.

SAGINAW, MICH.—The City Engineer has completed estimates for improving and paving 10 streets.

SUPERIOR, WIS.—Contracts have been awarded aggregating $391,630, and it is expected that bids will soon be asked for three others.

DREDGING.—Albany, N. Y.—The contract for dredging 8,000 cu. yds. at Bath and 4,000 cu. yds. in the Albany basin has been awarded to P. W. Myers at 14 cts. per cu. yd.

SEWERS.—Boston, Mass.—The Metropolitan Sewerage Commission has received the following proposals for Section 27 of the main sewer, in Somerville and Cambridge. The sewer will be 4,300 ft. long, 8 ft. outside diameter, and have an average depth of 25 ft. The bidders were as follows: (1) J. J. Newman, Providence, R. I.; (2) C. McBride, Brighton; (3) A. A. Libby & Co., Boston; (4) Delafield Construction Co., New York; (5) Jones & Meehan, Jamaica Plain; (6) National Construction Co., Boston; (7) C. G. Craib, Chelsea; (8) Everson & Liddle, Providence, R. I.; (9) H. P. Nawn, Boston; (10) Metropolitan Construction Co., Boston; (11) McGovern & Kitch, Lancaster, Pa.; awarded contract.

	Earth excav.			Masonry.				Spruce		
				Brick		Concrete		Rubble	Lumber	Piles
	60 × 78 ins.	62 × 69 ins.	Rock Excav.	Am.	Port.	Am.	Port.	Am.	in place.	driven.
	750	3,550	250	1,450	400	700	100	100	10 M.	1,000
	lin. ft.	lin. ft.	cu. yds.	cu. yds.	cu. yds	cu. yds.	cu. yds.	cu. yds.	ft. B. M.	lin. ft.	Total.
1.....	$13.65	$13.65	$3.50	$12.75	$14.75	86.40	$8.25	$6.00	$40.00	$0.15	$90,412
2.....	13.00	13.00	5.00	12.50	14.00	6.00	7.00	5.00	32.00	.25	86,845
3.....	10.50	10.50	4.00	13.00	14.50	4.98	4.98	4.98	25.00	.15	75,682
4.....	10.00	10.00	4.50	12.50	14.50	6.00	7.00	5.00	40.00	.15	74,000
5.....	10.90	9.60	6.00	12.00	14.00	5.00	7.00	3.00	28.00	.15	71,685
6.....	10.50	9.25	6.00	12.25	14.25	5.35	7.05	5.00	30.00	.20	71,125
7.....	9.50	9.00	4.00	13.00	14.25	5.00	6.25	5.50	30.00	.18	69,780
8.....	10.00	9.00	2.00	11.50	14.00	6.00	7.00	5.00	35.00	.14	68,115
9.....	10.00	9.00	3.00	12.25	14.00	3.00	5.00	1.00	25.00	.05	66,362
10.....	8.65	8.65	4.50	11.45	13.45	5.41	7.41	1.00	35.00	.15	65,430
11.....	8.00	6.50	2.00	11.00	12.40	4.65	6.50	5.00	22.50	.12½	55,240

BURLINGTON, IA.—Resolutions have been adopted for paving 15 streets with brick.

KANSAS CITY, MO.—Bids will be received until May 24 for five contracts, including grading, macadamizing, stone walks, etc. John Donnelly, Cy. Engr.

ST. LOUIS, MO.—The Board of Public Improvements asks for bids until May 27 for furnishing macadam and gravel for repairing the streets for one year.

SIOUX FALLS, S. DAK.—The Council has passed resolutions to pave nine streets with stone blocks.

SALT LAKE CITY, UTAH.—The Council has ordered $400,000 worth of paving.

TORONTO, ONT.—The Board of Public Works has recommended that several streets be widened 30 ft. and paved with asphalt.

ELECTRICAL.

WHITE RIVER JUNCTION, VT.—It is reported that O. W. Daly has purchased a water privilege at Lebanon, N. H., and will put in an electric light plant to supply this place, Hartford, West Lebanon, N. H., and Hanover, N. H.

PROVIDENCE, R. I.—The Council has appointed a special committee to consider the advisability of putting in a municipal electric light plant.

GOSHEN, N. Y.—The Goshen Light & Power Co. has been awarded a contract for not less than 8 arc and 119 incandescent lights for one year at $250 a month.

GREEN ISLAND, N. Y.—The citizens have voted in favor of electric street lighting. The estimated number of lamps required is 43.

HARRISBURG, PA.—The contract for street lighting has been awarded to the Harrisburg Electric Light Co. at $88.50 per light per year for lights of 2,000 c. p.

NORRISTOWN, PA.—The Norristown Electric Light Co. has been awarded a contract for 55 arc lights of 2,000 c. p. each, to burn every night from sunset to sunrise, at $100 per light per year.

SHAMOKIN, PA.—Bids are asked for electric street lighting. Frank A. Smink, Clk. of Council.

MARTINS FERRY, W. VA.—The city has voted $25,000 for a plant, and it is stated that immediate steps will be taken for its erection.

COLUMBIA, S. C.—The Committee on Lights has been authorized to investigate the cost of a municipal plant.

MT. CARMEL, ILL.—Bids are asked for an electric light and water works franchise. R. I. Wilkinson.

DETROIT, MICH.—Frank B. Rae is preparing specifications for a new electric light plant on Belle Island.

BOULDER, COLO.—The Boulder Electric Co. will add to its plant another engine, boiler and incandescent dynamo.

WEAVERVILLE, CAL.—Dr. S. B. Blake is securing estimates for an incandescent plant for lighting the city.

YOAKUM, TEX.—A contract was awarded May 13 to the San Antonio Improvement Co. for a plant to cost $15,000.

NEW COMPANIES.—Bradley General Electric Co., Chicago, Ill.; $1,000,000; H. C. Hartman, E. S. Douglas, F. L. Furber, Netfel & Marsh Co., Jersey City, N. J.; $50,000; to deal in electrical and other machinery; K. Netfel, C. W. Marsh, Jersey City, and H. M. Hawksworth, New York.

CONTRACT PRICES.

SEWERS.—Wilmington, Del.—We are informed by T. C. Hatton, Engineer in Charge of Sewers, that contracts have been awarded at the following prices: John McParland, Philadelphia, 33-in. brick, $4 per lin. ft.; 24-in., $3.75; 28x42 ins., $4.75; 20x30 ins., $3.40; 12-in. terra cotta pipe, $1.25; 6-in. Y's, $1.30; 6-in. slant in brick sewer, 25 cts.; inlets, $40 and $75; manholes, $50; salt glazed vitrified brick, $30; rock excavation, $4 per cu. yd.; Acock & Siddall, of Trenton, three sewers with 12 ft. cut, 66-in., brick, $13.50; 60-in., $13.85, $11.10; 54-in., $5.90; 48-in., $5.85; 42-in., $4.75; 24-in., $3.40; 30x45 ins. $4.69; 28x42 ins., $4.41; 26x39 ins., $4.16, $4.20; 33x22 ins., $3.75; 30x20 ins., $3.45; 34x51 ins., $5.35; 6-in. slant in brick sewer, 30 cts.; 18-in. terra cotta pipe, $1.45; 6-in. Y branches, $1.75; 15-in. pipe, $1.20; 6-in. Y's, $1.30; inlets, $49.50 and $54, according to plate; manholes, $55; catch basins, $40; flushing apparatus, $100; timber, $25; piles driven, 20 cts. per ft.; vitrified brick, $15; one brick sewer with 15 ft. cut, 48-in., $16.65; 34x51 ins., $5.35; 32x48 ins., $5.07; 28x42 ins., $4.41; 24-in., $3.50; other items same as in 12 ft. cut.

WELL.—Hillsboro, Tex.—A contract for sinking an artesian well has been awarded to the McLeod Artesian Well Co., Keokuk, Ia., at $3,900 for the first 1,200 ft., then $3 per ft. for 300 ft., and $4 per ft. thereafter up to 2,000 ft. It is to be a 6-in. well at the bottom.

LUMBER AND PAVING.—Brooklyn, N. Y.—The contract for about 500,000 ft. of lumber for the Brooklyn bridge has been awarded to Beers & Resignie at $11,000. The contract for asphalting the promenade was awarded to the Neuchatel Asphalt Co., New York, at 19⅝ cts. per sq. ft., or $6,200. E. H. Wooton bid 21½ cts. per sq. ft.

STREET WORK.—Kansas City, Kan.—The contract for paving State Line St. with Standard asphalt has been awarded to Mr. Hamilton at $1.84 per sq. yd.

Milwaukee, Wis.—The prices for improving 18 streets ranged as follows: Grading, 14 to 22 cts. per cu. yd.; cedar block paving, 99 cts. to $1.28 per sq. yd.; stone curbing, 58 to 72 cts. per lin. ft.; gutter paving, 36 and 44 cts. per sq. yd.

STREET SUPPLIES.—Cambridge, Mass.—The contract for 20,000 ft. of straight and 2000 ft. of circular edge stone has been awarded to S. & R. J. Lombard, Charlestown, at 46 and 59 cts. per ft. respectively.

Washington, D. C.—The lowest bid received for vitrified paving brick was that of McMahon, Porter & Co., $15.63 per M. for ordinary, and $15.88 for re-pressed.

Wilmington, Del.—The contract for 3,000,000 vitrified paving brick, about 46,000 sq. yds., has been awarded to the John Porter Co., Cumberland, W. Va., at $1.18½ per sq. yd.

RIP-RAP.—New York, N. Y.—The Department of Docks has awarded a contract for 2,000 cu. yds. of cobble and 4,000 cu. yds. of rip-rap to J. A. Bouker at 70 and 40 cts. per cu. yd. respectively.

RETAINING WALL.—Salt Lake City, Utah.—The contract for retaining walls for the city reservoirs in Parley's Canyon has been awarded to Wm. Harkins, at the following prices: Concrete and stone masonry, $5.75 per cu. yd.; coping, $2 per lin. ft.; grading, 80 cts. per cu. yd.

DRAINAGE.—Quincy, Ill.—The contract for draining Lima Lake has been awarded to J. E. Rogers, Tuscola, at 9 cts. per cu. yd. It is estimated that there will be 365,000 cu. yds. of drainage, and that the work will reclaim 5,300 acres of land.

PIPELAYING.—Boston, Mass.—The contract for laying 6-in. water pipe to Thompson's Island has been awarded to John Cavanagh & Co., Boston, as follows: 6,800 lin. ft. of pipe, 39 cts. per lin. ft.; 300 cu. yds. of rock excavation, $4 per cu. yd.

NEW YORK, N. Y.—The lowest bid for about 100,000 sq. yds. of granite block paving, opened May 17, was that of Matthew Baird, $3.29 per sq. yd.

MISCELLANEOUS.

DREDGING.—Ishpeming, Mich.—Bids are asked until May 26 for dredging about 40,000 cu. yds. in Carp River. W. H. Johnston, Chn., Sewer Committee.

Providence, R. I.—Bids are asked until May 25 for dredging about 8,000 cu. yds. C. D. Sellew, Chn., Harbor Committee.

Hayattsville, Md.—It is proposed to dredge the Eastern Branch to a depth of 15 ft. with a width of 45 ft. at the bed, and 75 ft. at the surface, at an estimated expense of $100,000. Surveys are now being made.

PIER AND CRIB WORK.—Duluth, Minn.—Bids are asked until June 14 for constructing a crib and repairing a pier. Capt. W. L. Fisk, U. S. Engineer Office.

SUPPLIES.—Washington, D. C.—Bids are asked until June 7 for 19 classes of supplies, including electrical battery supplies, drain pipe, sand, lime and cement, brick and lumber. Col. O. H. Ernst, Office of Public Buildings and Grounds, War Dept.

DRY DOCK.—Washington, D. C.—Bids are asked until July 19 for a timber dry dock, 600 × 28 ft., at the Brooklyn Navy Yard. N. H. Farquhar, Chief of Bureau of Yards and Docks.

DREDGE HULL.—Ottawa, Ont.—Bids are asked until June 3 for a hull for a steam elevator dredge, 152 × 30½ ft. E. F. E. Roy, Secy., Dept. Pub. Wks.

PARKS.—Somerville, Mass.—$25,000 has been appropriated for improving Powder House Park.

Whitinsville, Mass.—Work on a public park has been commenced by A. C. Moore, Southbridge.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Rhode Island Locomotive Works, Providence, R. I., has built two ten-wheel engines and two six-wheel swith engines for the Malne Central, and a switch engine for the New York, New Haven & Hartford; they are also building a 45-ton engine for the Saltair. The Schenectady Locomotive Works, Schenectady, N. Y., have built a freight engine for the Connecticut River, and are at work on ten ten-wheel engines for the Chicago & Alton.

CARS.—The Mount Vernon Car Co., Mount Vernon, O., has orders for 300 flat cars, 36 ft. long, for the Evansville & Terre Haute, and for box cars for the Mobile & Ohio. The Ohio Falls Car Co., Jeffersonville, Ind., has an order for six passenger cars for the New York, Ontario & Western. The Laclede Car Co., St. Louis, Mo., has an order for 10 combination cars for the Duquesne Traction Co., of Pittsburg. The Ohio Southern has recently placed orders for 500 box cars and 500 coal cars.

IRON WORK. The contract for furnishing the Z-bar columns for the Y. M. C. A. building, at Chicago, Ill., has been awarded to the Kenwood Bridge Co., of Chicago. The I-beams will be furnished by the Illinois Steel Co., of Chicago.

MERRILL-STEVENS CATTLE GUARD.—In our issue of April 21 we published a half page advertisement of the Merrill-Stevens Mfg. Co.'s cattle guard, made at Niles, Mich. There was not time enough to submit proofs and by an oversight of the printer, serious errors occurred in the advertisement. We publish a corrected copy of the advertisement this week.

GRAPHITE PAINT.—A new brand of graphite paint has been brought out by the Detroit Graphite Mfg. Co., which works extensive mines in north Michigan, near Houghton. The graphite is claimed to be very pure and to make when pulverized a finer powder than ordinary brands. It is furnished either in bulk or ground in oil and can be furnished more cheaply than even iron ore paints. It is especially recommended for painting iron work, and it is stated that the hulls of many of the new lake vessels are being painted with it. Among some of the users of the paint are the Detroit Ridge & Iron Works and the Grand Trunk Ry. Co.

THE PITTSBURG TESTING LABORATORY, Pittsburg, Pa., has been engaged through Mr. W. A. Aiken, Western representative, Chicago, to inspect 800 tons of steel for three bridges on the Great Northern Ry., N. D. Miller, Chief Engineer, at St. Cloud and Crookston, Minn.

THE NATIONAL PAINT WORKS, Williamsport, Pa., have a contract for paint for five of the main buildings at the World's Columbian Exposition.

THE SOMERVILLE CREOSOTING WORKS will be sold at Charleston, S. C., May 26. The plant is for the injection of oil of coal tar under pressure, and includes four cylinders 40 × 2½ ft., four 50 × 2½ ft., and one 50 × 5 ft. Gaston Hardy, Charleston, S. C.

THE AURORA IRON WORKS, Aurora, Ill., have removed their general office and salesrooms to 175 Lake St., Chicago. This company manufactures the Bignall peerless stopcock boxes, special castings, etc. Pres., R. B. Bignall; Secy., Geo. T. Hinds; Treas., C. P. Walcott.

THE GROTON BRIDGE & MFG. CO., Groton, N. Y., reports contracts for over 50 bridge spans, including four 153 ft. spans for the Allegany Bridge Co., Warren, Pa.; a 243 ft. span with trestle approaches for Claiborne Co., Miss., and a plate girder span for the Lehigh Valley R. R., at Lower Catasauqua, Pa. Work has been commenced on the steel intake pipe for the Syracuse water-works and the company is turning out a large order of the Milliken patent pole for electric railway and lighting work.

THE OWEGO BRIDGE CO., Owego, N. Y., is putting in its plant, which will be driven by a 35 HP. engine.

NEW COMPANIES.—U. S. Development Co., East St. Louis, Ill.; $100,000; H. H. Thompson, H. W. Adams and W. H. Long. B. & J. Car Coupler Co., Des Moines, Ia.; $2,500,000; W. G. McClure and A. A. Brown. Chicago Surveying & Engineering Co., Chicago, Ill.; $25,000; F. P. Henry, R. S. Iles, Alfred Stubbins, Delbert Engineering Co., New Orleans, La.; $100,000; Pres., A. F. Delbert; Secy., T. V. Regan. Standard Air Brake Co., East St. Louis, Ill.; $4,000,000; George E. Paul, F. Wesemann and C. M. Linhart. Western Harris Gas Co., Chicago, Ill.; $10,000,000; W. H. Harris, J. O. Lee and Clarke Gapen. Vulcan Construction Co., Chicago, Ill., $250,000; W. H. Taylor, J. D. Cameron and J. S. Given.

CURRENT PRICES.

RAILS.—New York; $30 at Eastern mills, $30.75 at tidewater; old rails, $19 for iron and $15 to $15.50 for steel. Pittsburg: $30; old rails, $21 for iron and $15.50 to $16.50 for steel. Chicago: $31.50 to $32; old rails, $18 to $19 for iron and $13 to 14 for steel.

TRACK MATERIALS.—New York; steel angle bars 1.65 to 1.75 cts.; spikes, 2 to 2.05 cts.; track bolts, 2.65 to 2.75 cts. with square and 2.8 to 2.85 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.8 cts. for iron and 1.8 to 1.9 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.7 to 1.72 cts. for iron and steel; spikes, 2.1 to 2.15 cts.; track bolts, 2.55 cts. with square and 2.65 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½ per cent. on black and galvanized butt-welded; 67½ and 55 per cent. on black and galvanized lap-welded. Casing 55 per cent.

FOUNDRY PIG IRON.—New York: $14 to $16. Pittsburg: $13.75 to $14.75. Chicago: $13.50 to $15.

LEAD.—New York; 4.25 to 4.3 cts. Chicago: 4.15 to 4.17 cts. St. Louis: 4.07 cts.

STRUCTURAL MATERIAL.—New York; beams, 2.3 to 2.45 cts.; channels, 2.25 to 2.5 cts.; angles, 1.9 to 2.1 cts.; tees, 2.4 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.85 to 1.95 cts. for tank, 2.05 to 2.25 cts. for shell, 2.35 to 2.65 for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2 to 2.1 cts. channels, 2 to 2.1 cts.; angles, 1.85 to 1.9 cts.; tees, 2.5 cts.; universal mill plates, 1.8 to 1.9 cts. for iron and steel; sheared steel bridge plates, 1.95 to 2 cts.; refined bars, 1.7 for iron and 1.75 for steel; steel plates, 1.9 cts. for tank, 2 to2.1 cts. for shell, 2.15 to 2.25 cts. for flange, 3.5 to 4 cts. for firebox. Chicago: beams, 2.1 to 2.15 cts.; channels, 2.1 to 2.15 cts.; angles, 1.85 to 1.9 cts.; tees, 2.04 cts.; universal plates, 2 cts.; sheared steel plates, 1.95 cts.; steel plates, 2.3 to 2.4 cts. for tank, 2.6 to 2.75 cts. for shell, 2.9 to 3 cts. for flange.